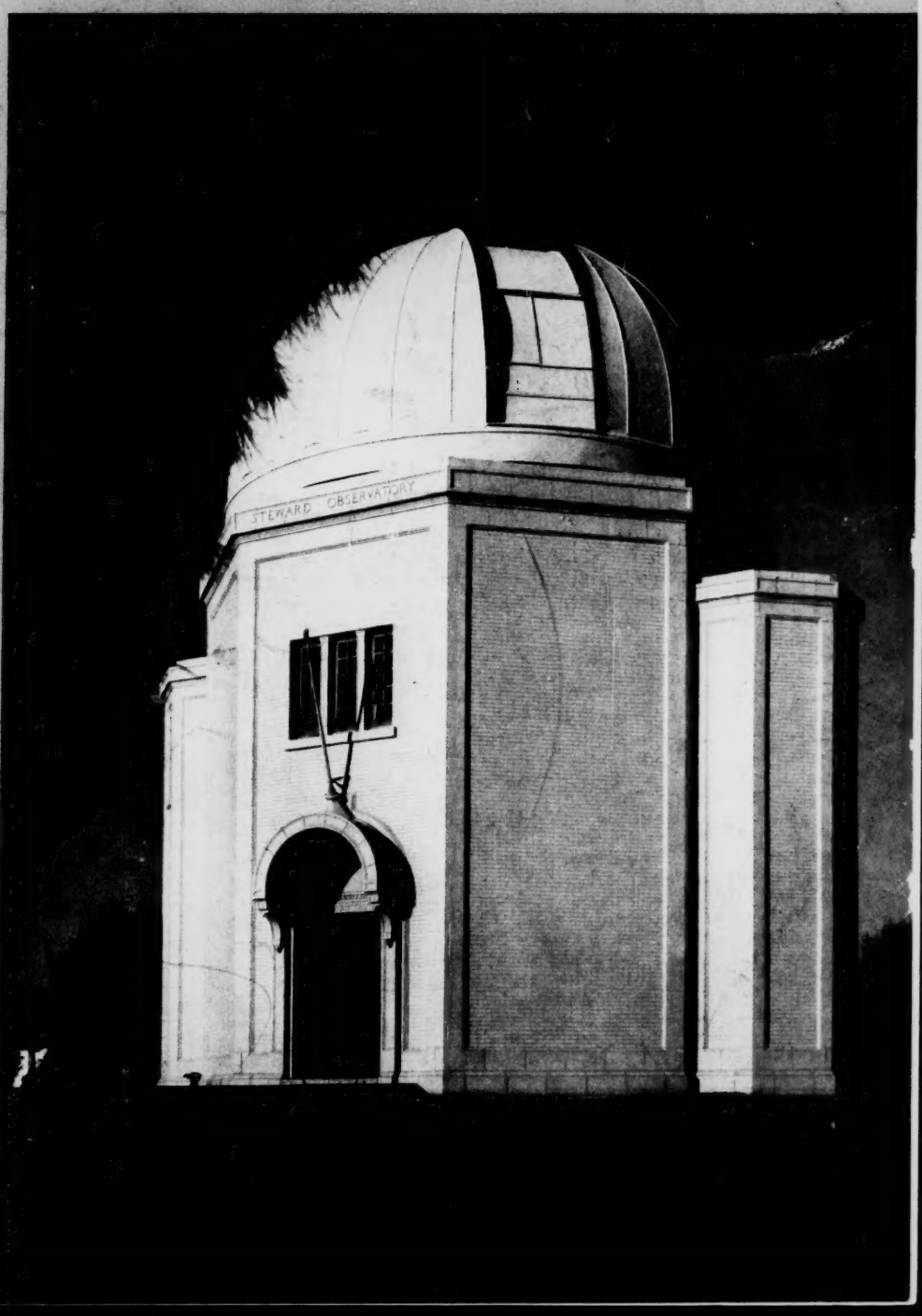
MAR 10 1950

Sky and TELESCOPE



In This Issue:

Current Problems of Pluto

Stars as Magnets

Tucson Trail

American Astronomers Report

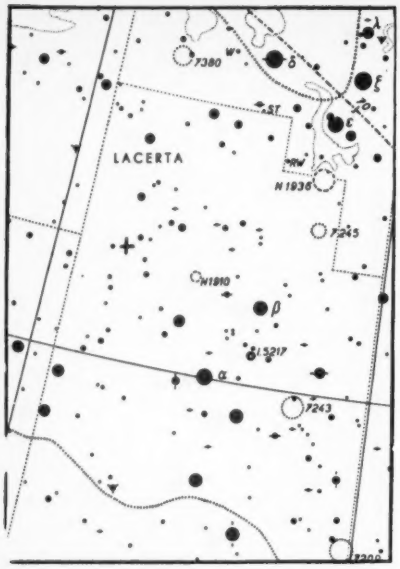
Northern and Southern Star Charts

★

Vol. IX, No. 5
MARCH, 1950
Whole Number 101
25 cents

★

Steward Observatory



This is a portion of the Skalnate Pleso "Atlas of the Heavens," showing Lacerta and a corner of Cepheus (upper right). The reported position of Bertaud's nova is plotted as a cross. North is at the top, whereas on page 105 the photograph and field are inverted, with south at the top.

Nova Lacertae 1950

ON WEDNESDAY morning, January 25th, a cablegram arrived at the Harvard Observatory clearinghouse from Copenhagen announcing the discovery on January 23rd of a 6th-magnitude nova. It was found by Charles Bertaud, of Meudon Observatory, France, in the position $22^h\ 48^m.0$, $+53°\ 2'$. A cross has been placed in that position (left of center) on the chart above, and a photograph of the field may be found on page 105.

As soon as the message was received and decoded, telegrams and air mail letters were sent to scattered points across the country, with the hope that somewhere there would be clear skies. Harvard Announcement Card 1059 carried the news, and Mrs. Margaret W. Mayall, recorder of the AAVSO, notified some of the society's observers. In addition, she issued special blueprint charts showing the nova's position.

The first response was from Washington, D. C. Three members of the AAVSO and the National Capital Astronomers, Morgan Cilley, Miles Davis, and John Lankford, made visual estimates of the nova's brightness as magnitudes 6.3, 6.5, and 6.1, respectively. Earlier that night (January 25th), Drs. John S. Hall and A. H. Mikesell had found the magnitude to be 6.1 with a photoelectric photometer at the U. S. Naval Observatory.

Observations on the night of January 27th were reported by Davis, Robert Greenley, Richard Hamilton, Lankford, Mrs. Mayall, Robert Pearcy, and William Penhallow, for a mean magnitude of 6.3.

(Continued on page 105)

Sky and TELESCOPE

Copyright, 1950, by
SKY PUBLISHING CORPORATION

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

EDITORIAL ADVISORY BOARD: *Clement S. Brainin*, Amateur Astronomers Association, New York; *Edward A. Halbach*, Milwaukee Astronomical Society; *Donald H. Menzel*, Harvard College Observatory; *Paul W. Merrill*, Mount Wilson Observatory; *Charles H. Smiley*, Ladd Observatory; *Percy W. Witherell*, Bond Astronomical Club.

LETTERS

Sir:

January 30th at 9:00 a.m. PST I began observations of Venus near inferior conjunction, and saw the planet plainly with my unaided eye after first having located it with binoculars. The planet was observed at 12:35, 2:00, and 4:30 p.m., without optical aid. At 2:00 I observed it first with binoculars, but clearly saw it with the naked eye while standing in full sunlight and using only my hands to shade my eyes. At 10:00 a.m. on the 31st, I again observed Venus with the naked eye, 11 hours after inferior conjunction. I repeated this at 1:30 that afternoon. These observations require a definite technique, good eyes, and patience.

JOEL PALMER
Route 1, Box 67
Saratoga, Calif.

Sir:

As Mars was so close to Gamma Virginis on the morning of January 26th, I wonder if there was any location where the planet was seen to occult the star.

On Sunday evening, January 29th, I saw Venus at 5:20 p.m. PST with opera glasses, and got a couple of glimpses of it with the naked eye. I saw it rise at 7:00 a.m., half an hour before sunrise the following morning, with glasses and naked eye; this was 16 hours before conjunction. That evening and on the morning of the 31st I was clouded out, but on the evening of the 31st I saw it with opera glasses, setting about 15 minutes after the sun.

FRANK TRATHEN
2694 Linda Vista Ave.
Napa, Calif.

Sir:

On January 8th, about 2:40 p.m. PST, I saw here one of the rarer types of solar halos — a segment of the zenith circle (that facing the sun symmetrically), about 60°, blue on the inside. A snowfall had just broken up.

RAY HEFFERLIN
311 Grainger, Pacific Union College
Angwin, Calif.

Sir:

We had an excellent view of Canopus on January 25th, between 10 and 11:20 p.m., from this latitude of 35° 57′ 34″ N. I wonder if it has been seen any farther north? It was very nearly on the meridian when we first saw it, at that time about 1½° above the horizon and quite bright.

FRANK B. DINWIDDIE
Nags Head, N. C.

VOL. IX, NO. 5
WHOLE NUMBER 101

MARCH, 1950

CONTENTS

COVER: The Steward Observatory of the University of Arizona, Tucson, where the 82nd meeting of the American Astronomical Society was held December 28-31, 1949. The building houses a 36-inch reflector, mirror by Brashear, mounting by Warner and Swasey. Photograph by Maynard L. Parker. (See page 109.)

CURRENT PROBLEMS OF PLUTO — Dirk Brouwer **103**
STARS AS MAGNETS — Otto Struve **106**
TUCSON TRAIL **109**
AMERICAN ASTRONOMERS REPORT **114**

Amateur Astronomers **112**
Books and the Sky **118**
Gleanings for ATM's **120**
Letters **102**
News Notes **116**
Observer's Page **123**
Planetarium Notes **119**
Southern Stars **127**
Stars for March **126**
Terminology Talks **105**

BACK COVER: The spiral galaxy NGC 628, in the constellation of Pisces. One of the brighter and larger spirals, it is at a distance of about five million light-years. The red shift in its spectrum corresponds to a motion away from the earth of approximately 300 miles per second. Its magnitude is 12.3, and it is located at R. A. $1^h\ 34^m.0$, Dec. $+15°\ 32'$. It is a spiral of type Sc, about 8′ in diameter. This picture was taken recently with the full aperture of the 200-inch telescope with an exposure of only 20 minutes. Note the many very faint outlying portions. Mount Wilson and Palomar Observatories photograph.

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $3.00 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.50; all other foreign countries, $4.00. Make checks and money orders payable to Sky Publishing Corporation. Canadian and foreign remittances should be made in United States currency. Circulation manager: Betty G. Dodd.

All notices of change of address must be sent three weeks in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts unless return postage is provided by the author.

TWENTY YEARS AGO, on March 13, 1930, it was announced that the outermost planet, Pluto, had been discovered by Clyde W. Tombaugh at the Lowell Observatory, after an extensive search of many years. The 20th anniversary of the discovery seems to be an appropriate occasion for a review of what has become known concerning this distant member of the system of principal planets.

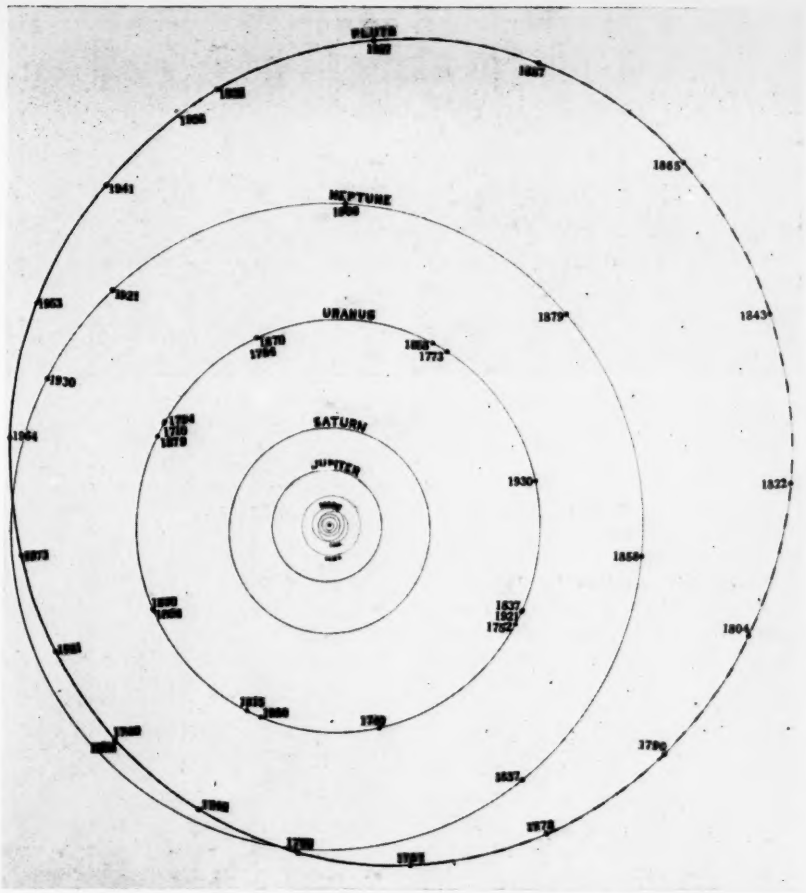
Two decades is a short interval in the course of a planet that requires about 250 years to complete its circuit around the sun, yet there has been sufficient time for the acquisition of a considerable body of well-established facts. If a number of questions remain unanswered, this is only to be expected of a planet that is so faint and distant that the first measurement of its angular diameter was accomplished only during the past year.

This result was announced by Dr. G. P. Kuiper, of Yerkes and McDonald Observatories, at the recent meeting of the American Astronomical Society at Tucson. He had tried this measurement many times before, unsuccessfully. However, on a night when the seeing was just about perfect, and when the 82-inch mirror of the McDonald Observatory was in very excellent condition, he succeeded. The angular diameter was found to be about 0.4 second of arc. A disk meter was used; without using artificial images produced by a disk meter for comparison, the measurement would have been impossible. Dr. Kuiper estimates that Pluto's apparent diameter may conceivably be slightly greater, but has probably been obtained correctly within about 10 per cent.

A considerable portion of Dr. Kuiper's communication dealt with the conclusions that may be derived from the angular diameter. Walter Baade has determined the magnitude of Pluto to be 14.3. With this magnitude and the angular diameter 0.4 second of arc, the albedo or reflecting power is found to be 0.06. This is very nearly the same as the albedo of the moon and Mercury, usually quoted as 0.07. An angular diameter of 0″.4 at a distance of 36 astronomical units corresponds to a linear diameter of 0.8 times that of the earth. Hence Pluto is a much larger body than the moon or Mercury. According to the best evidence available, the mass of Pluto is 0.9 or 0.8 times the mass of the earth, and the density is nearly the same as the earth's.

One would expect that such a body would have an atmosphere. Since a dense atmosphere would correspond to a high albedo, it cannot have a dense atmosphere. It is impossible to account for the faintness of Pluto except by making it almost black. If the color were very red, the color index would come out very large. This is not the case; the color index is 0.66, about that of a *G*5 star.

In view of the apparent absence of an appreciable atmosphere, rather surprising for a body of nearly the size and mass of the earth, it is important to ask with what degree of certainty the mass of Pluto has been determined. This is an interesting question that I shall review here.



The principal solar system orbits, drawn to scale and projected on a common plane. The date 1989 applies to Pluto, not Neptune. Lowell Observatory chart.

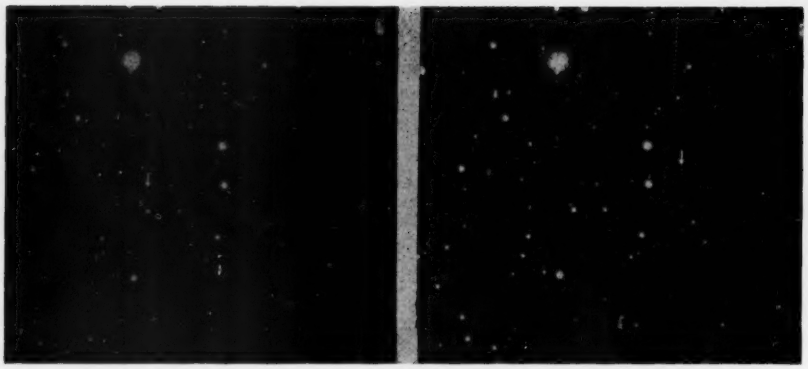
Current Problems of Pluto

BY DIRK BROUWER, *Yale University Observatory*

Within six years after discovering Uranus, Sir William Herschel found the two bright satellites, Titania and Oberon. The existence of a satellite to Neptune was established by Lassell soon after the discovery of that planet in 1846. No such good luck followed the discovery of Pluto. For all we know, Pluto travels its circuit around the sun unattended by any satellites. Hence, while the masses of Uranus and Neptune could be deduced rather easily from the scale of the satellite orbits, the mass of Pluto can be derived only from its gravitational attraction upon other planets. It turns out that the determination from Pluto's attraction on Neptune is so very much better than from its attraction on Uranus that it is correct to say that, for all practical purposes, our present knowledge of Pluto's mass depends exclusively on an analysis of the observations of Neptune.

A first mass determination of Pluto, from perturbations on the longitude of Neptune, was made by S. B. Nicholson, of Mount Wilson Observatory. I well remember reading his paper in his absence at the Christmas meeting of the American Astronomical Society in New Haven in 1931. In the discussion that followed, W. S. Eichelberger, who had taken a considerable part in the construction of Newcomb's theory and tables of Neptune, remarked that he felt that a revision of the perturbations used in the tables of Neptune might be necessary before the result could be accepted. Nicholson had found for the mass of Pluto the value 0.94 times the mass of the earth, with a probable error of about one quarter of this amount.

I must confess that on the grounds of Dr. Eichelberger's remark, I felt quite skeptical about this determination. The remarkable thing is, however, that all that has since been done on this problem



Small sections of the plates that were blinked on February 18, 1930, by Clyde W. Tombaugh, showing the discovery positions of Pluto, marked by the arrows. Note the motion of the planet between January 23, 1930 (right) and January 29, 1930 (left). Lowell Observatory photograph.

— which is a good deal — has substantially confirmed the result obtained by Nicholson. Several years after Nicholson published his results, L. R. Wylie, then at the U. S. Naval Observatory, began a new reduction of the observations of Neptune. At the same time I carried out a numerical integration of the orbit and compared it with Newcomb's theory. While it turned out that Newcomb's tables are in need of some corrections, these defects do not affect the validity of the procedure followed by Nicholson and, later, by Wylie. The only additional evidence that turned up as a result of these later discussions was that Neptune's latitudes could also be used to give a determination of the mass of Pluto. This value was in excellent agreement with that derived from the longitudes. Together they appear to determine Pluto's mass at about 1/360,000 of the sun's mass or 9/10 of the earth's mass, with a probable error only about 10 per cent of this amount. So far there seems to be no reason to question the reliability of this result. It is useful, however, to examine the details of the determination.

Since 1846, Neptune has been continuously observed for a little more than half its period of revolution. The perturbations on Neptune in longitude during this period, if adjusted by a change in the orbital elements of Neptune, are very small. With a mass of Pluto of the order of the earth's mass, they are too small to be detected with certainty in the observations of Neptune. The entire determination of the mass of Pluto thus depends on the pre-discovery observations of Neptune made at Paris by Lalande on May 8 and 10, 1795. These observations were carefully reduced by Newcomb and newly reduced by Wylie. They are accordant, and with the best adjustment of the modern observations, the residual in longitude from the mean of the two observations becomes:

Pluto's Mass (Sun=1)	*Residual*
0	−8″.4
1/720,000	−4″.9
1/360,000	−1″.6
1/300,000	−0″.3

It appears, therefore, that the mass of Pluto may be reduced to one half of its adopted amount only at the cost of a residual of about five seconds of arc in the mean of the two Lalande observations.

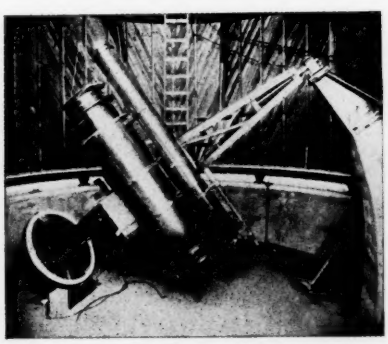
In the case of the latitudes, the Lalande observations are of no value whatsoever. A residual of −1″.5 remains with any reasonable value for the mass of Pluto. The modern latitude residuals show a systematic trend if no allowance is made for the attraction by Pluto. A mass of 1/360,000 times the sun's mass fits these latitude residuals, and a significant change in this mass of Pluto can be accepted only if it is assumed that the fundamental declination system during the past century is in need of larger corrections than we are ready to accept.

I remarked that Uranus adds very little information. Recently I examined the Uranus residuals again. The solution indicates a smaller mass for Pluto than that derived from Neptune, but the uncertainty is so great that one can hardly speak of a contradiction.

The conclusion is that only the accumulation of later observations can throw further light upon this question. The observations used in the present discussion go to 1938 only. A new discussion may be warranted by 1960 or 1965. As time goes on, the Lalande observations become less important. Certainly before the end of the 20th century the observations will tell whether there is something abnormal about the present solution for Pluto's mass. So far as currently available data can tell us, there is little if any indication of the presence of a trans-Plutonian planet.

The orbit of Pluto is now reasonably well known. The orbit used for ephemeris calculations is one obtained by E. C. Bower. He included observations in four oppositions preceding the optical discovery, the earliest observation being in January, 1914. This orbit has served exceedingly well. Even at the present time the deviations of the observations from this ephemeris are quite small.

Recently, C. O. Lampland, of the Lowell Observatory, has begun the measurement of some 700 photographic plates of Pluto secured at Lowell since 1930. A plan for the utilization of this rich material has been set in motion during the past year. In previous work on Pluto, the photographic positions of



The 13-inch telescope with which the final search for Pluto was carried on at the Lowell Observatory.

MARCH 13th AND SOME PLANETARY HISTORY

ANNOUNCEMENT of the discovery of Pluto was made by the Lowell Observatory on March 13, 1930. This was the same date as that in 1781 when Herschel found the planet Uranus, and it was also the day of Percival Lowell's birth in 1855.

Lowell is famous for his studies of Mars, but it was partly in expectation of finding a trans-Neptunian planet that he founded the Lowell Observatory at Flagstaff, Ariz. A year before his death in 1916 he published a paper predicting the probable position in which a planet that was disturbing the orbits of Neptune and Uranus might be located. Actually, the planet had already been photographed, but it was not to be found for another 15 years.

By means of a blink microscope, Clyde W. Tombaugh compared plates of the same region taken at different times with a 13-inch photographic telescope that was given to Lowell Observatory by Percival's brother, President A. Lawrence Lowell, of Harvard University. Tombaugh's search started in March, 1929, and on February 18, 1930, he found the planet on two plates taken on January 23 and 29, respectively. The new object was checked on another plate taken January 21, and this date is sometimes given as that of the discovery.

The name Pluto was suggested by an 11-year-old English girl. Its first two letters and the symbol for the planet contain Lowell's initials.

the planet have usually been derived from *Astrographic Catalogue* positions of faint comparison stars. For the project now under way, the star positions will be derived from plates taken for this purpose with the powerful 20-inch astrograph of the Lick Observatory. Plates with the same centers were also secured with the 5-inch Ross lens of the Yale Observatory. Finally, C. B. Watts and his associates at the Naval Observatory have observed with the 6-inch meridian circle some 250 stars along the path of Pluto during the 20 years, 1930 to 1950. These observations were combined with earlier observations by H. R. Morgan, who has just completed an excellent special little star catalogue from this material. With all these provisions it will be possible to reduce the Pluto positions to a well-defined system.

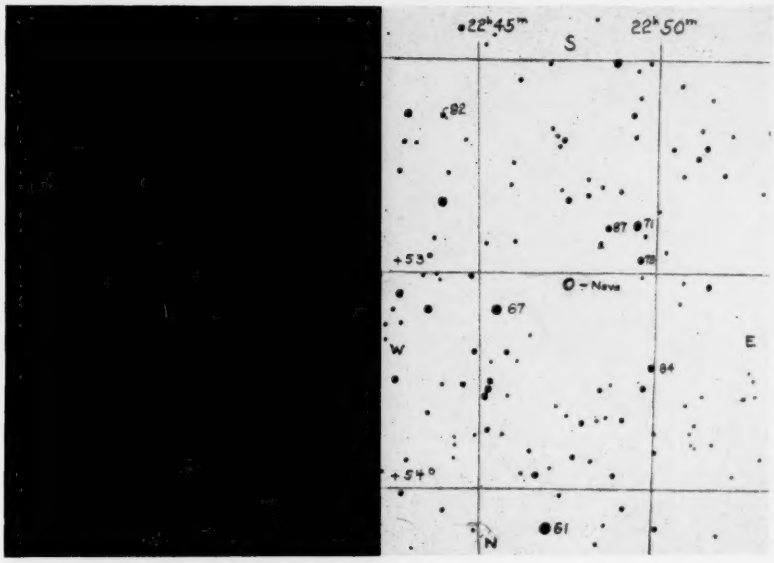
This is all a part of a comprehensive project supported by the Office of Naval Research on the motions of the principal planets, undertaken as a co-operative enterprise of the United States Naval Observatory, the Watson Scientific Computing Laboratory, and the Yale Observatory. As another part of this project, the orbits of the five outer planets, Jupiter, Saturn, Uranus, Neptune, and Pluto, were computed by numerical integration with the Selective Sequence Electronic Calculator of the International Business Machines Corporation, from 1780 to the present time. This work is of a much higher accuracy than earlier calculations. Comparisons of this integration with Newcomb's tables of Uranus and Neptune were used in the discussion of the observations of these planets reported in this article.

NOVA LACERTAE 1950

(Continued from page 102)

The next night the nova was observed by Leslie C. Peltier, and on the 30th by Robert A. Naef in Switzerland, still about the same brightness. But by February 5th the star had faded about half a magnitude, and on February 7th John Holloway and Jeremy Knowles estimated it at 7.2.

Meanwhile, Dr. Dean B. McLaughlin reported that in spectra taken on January 27th and 28th at the University of Michigan Observatory the general appearance was like that of Nova Herculis 1936 two weeks after maximum light, but the bright bands were wider and the absorption lines more displaced. At Harvard's Oak Ridge station, Dr. Armin J. Deutsch procured spectra with the 61-inch Wyeth reflector. He found the Balmer lines complex in nature, with the emission components having total widths corresponding to velocities of about 1,500 kilometers per second. The interstellar H and K lines of ionized calcium were strong.



A contact print of the nova field, taken with the Harvard 16-inch Metcalf refractor on February 4th by Vainu Bappu, a 15-minute exposure interrupted by clouds. The nova is bright, near the center, as shown by the corresponding portion of an AAVSO chart at the right, drawn by John Holloway. The preliminary magnitudes of some stars are given, with the decimal points omitted in accordance with the usual practice among variable star observers.

TERMINOLOGY TALKS

J. Hugh Pruett

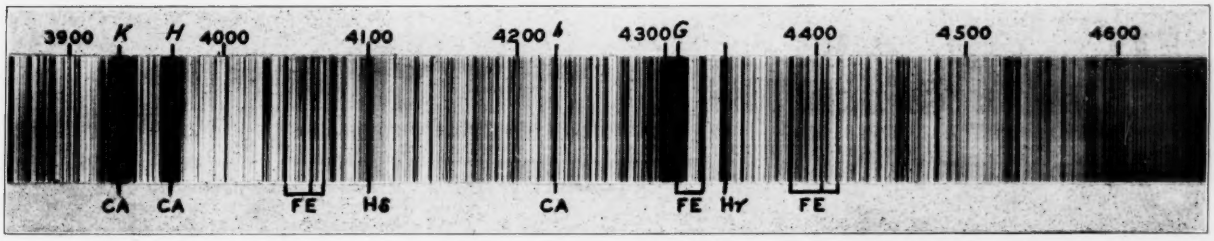
Dark-line Spectra

There is a third type, the *dark-line* or *absorption spectrum*. The spectra of the sun and most of the stars are dark-line. They consist of a continuous rainbow of color crossed by thousands of dark lines, some fairly wide, others mere threads. The best spectrograph reveals about 25,000 solar dark lines, named Fraunhofer lines after their first thorough observer.

When radiations from a luminous source pass through a cooler gas, this gas absorbs the colors or wave lengths it would itself give if luminous. The visible surface of the sun gives a continuous spectrum, because it is a dense gas. But as this light passes through the relatively cooler and rarer gases of the sun's own atmosphere, the latter absorb thousands of wave lengths from the continuous band and thus leave dark spaces in it. The positions of the dark lines reveal to earth dwellers the identity of the elements in the solar atmospheric gases.

Telluric and Interstellar Lines

In the spectra of both sun and stars are found some dark lines that have been caused by the absorption of the light by the gases of the earth's own atmosphere. These are called *telluric lines*. There are other lines in the spectra of the stars that are produced by the atoms of various gases in interstellar space, and these are called *interstellar lines*. Generally, such lines are stronger for more distant stars, because their light has had to pass through a greater amount of interstellar matter in reaching the earth.

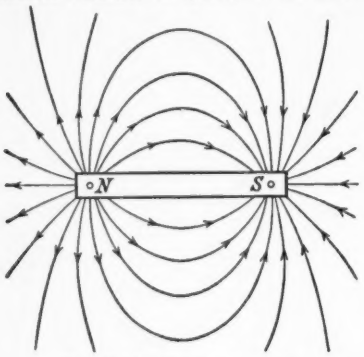


A part of the spectrum of the sun, typical of the dark-line spectra of the stars. The wave lengths in angstroms are marked along the top, with the shortest waves at the left. Note the heavy lines of ionized calcium in the violet; these were labeled H and K by Fraunhofer. Some other lines from hydrogen and iron are also labeled. Mount Wilson Observatory photograph.

STARS AS MAGNETS

By Otto Struve, *Yerkes and McDonald Observatories*

IN 1947, Horace W. Babcock announced that the star 78 Virginis, observed by him at Mount Wilson, behaves as an enormous magnet, with an intensity of the magnetic force in its atmosphere far in excess of that of the earth and resembling that of the most powerful electromagnets produced, in minute volumes of space, in the laboratory. This discovery was the culmination of a long series of investigations which started early in 1908, when G. E. Hale recognized that the hydrogen flocculi of the sun frequently resemble the distribution of iron filings in the vicinity of a magnet. A few months later, on June 25, 1908, he succeeded in establishing that the spectral lines of the sun observed in and near a sunspot are, indeed, influenced by what is called the Zeeman effect: A single spectral line produced by an ordinary light source, such as an iron arc, is split up into several component lines, usually quite close together, when the emitting atoms are located between the poles of a strong magnet; this magnetic splitting of the lines is different, depending on whether we observe the light source at right angles to the direction joining the two magnetic poles or along this direction.



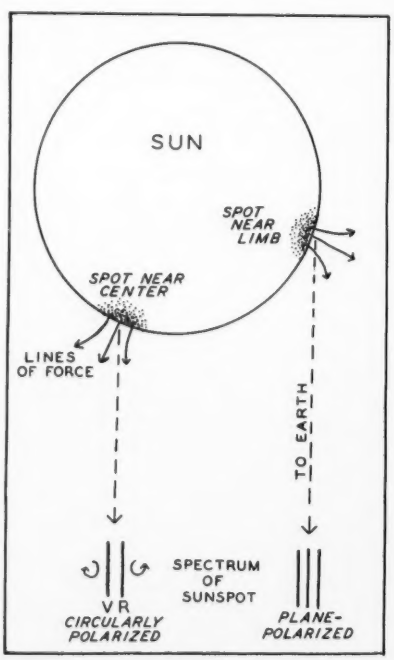
The field of a bar magnet.

It is customary to describe the properties of magnetism by means of the concept of a magnetic field which is represented by a pattern of *force lines* indicating the direction of the magnetic force of attraction or repulsion. In the case of an ordinary electromagnet, in which the poles are brought close together, the force lines between the two poles are straight lines and the intensity of the field is approximately constant. In the case of a bar magnet, in which the two poles are separated by a straight piece of iron, the field lines emerge radially from the north pole and curve around so as to enter the south pole.

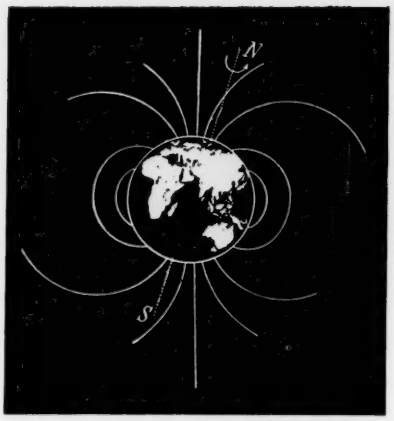
If a magnetic needle, capable of turning in all directions, is placed in the field of a bar magnet, it assumes a direction given by the slant of the force lines. If an incandescent gas is located in the vicinity of a magnet, the splitting of a spectral line observed at right angles to the field lines produces three components, in the simplest cases. The central component is in the exact position of the undisturbed spectral line, while the two other components are shifted symmetrically toward the red and the violet sides, the amount of the shift being proportional to the intensity of the field. All three components are plane-polarized, but the direction of polarization of the two outer components is at right angles to that of the central component.

When we observe the gas along or parallel to the direction of the force lines, the central component is absent and the two outer components show circular polarization. An ordinary piece of polaroid filter records no difference in the brightnesses of these two components when it is turned 90 degrees. Nevertheless, the light is not of the usual unpolarized variety.

We can best picture the phenomenon of polarization by assuming that the light produced by an atom is caused as the result of vibrations of an electron attracted to an atomic nucleus by some kind of an elastic force. If the electrons of all the atoms oscillate precisely in one direction, there will be no light emitted in this direction and there will be a maximum of intensity at right angles to it. This is a well-known property of atoms as light sources. In the Zeeman effect observed transverse to the force lines, some electrons vibrate in one direction to produce the central component and others, whose frequencies are disturbed, vibrate at right angles to this direction to produce the outer components. But in each case the electrons vibrate strictly in a single plane. When we observe the light longitudinally, we must think of the electrons as moving in circular orbits around the atomic nuclei, the planes of their orbits all being parallel to one another and the directions of motion being opposite for the two displaced Zeeman components.



This diagram shows the positions in which sunspots produce the two simple kinds of Zeeman effect in the sunspot spectrum. The reader is looking down at the polar regions of the sun, and the paper is the plane of the ecliptic.



The general magnetic field of the earth. The axis of rotation is dotted.

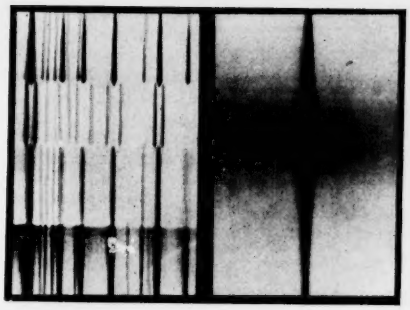
We can, however, convert circular polarization into plane polarization by a simple trick: We insert into the beam of light a piece of doubly refracting crystal whose optical axis is perpendicular to the beam. In that case the two components of the circular vibration are transmitted with different velocities through the crystal, and it is possible to adjust the thickness of the latter in such a way that the slower beam will be retarded by 90 degrees, causing it to coincide in phase exactly with the faster beam. Such a plate, made of quartz or mica, is called a quarter-wave plate. In the Zeeman effect it is customary to employ a quarter-wave plate in front of the spectrograph. The two components then remain of the same intensity as before, but they become plane-polarized in opposite planes and can be alternately extinguished by rotating a polaroid filter.

Now let us return to the problem of the stars. In 1913, Hale announced that he and his associates at Mount Wilson Observatory had detected a general magnetic field of the sun. According to this result, the sun must be regarded as a magnetized sphere, somewhat like the earth. We can imagine that in the center of the earth, or of the sun, there is

something resembling a bar magnet which we shall call a magnetic dipole. Its axis is inclined to the axis of rotation by about six degrees for the sun and 11 degrees for the earth. At the magnetic pole the field lines are straight, while near the equator they are greatly curved.

In order to obtain a quantitative estimate of the strength of the magnetic field of the sun it is necessary to define the unit of magnetic field strength. In modern work this unit is called the *oersted,* but in the older literature and in most contemporary astronomical applications the word *gauss* is used. The difference between these two units is not important in astronomical applications and we can therefore use them interchangeably. One oersted or one gauss represents a magnetic field in which a force of one dyne is exerted upon a magnetic pole of unit strength. The magnetic field of the earth is only a few tenths of an oersted. The strongest magnetic fields of electromagnets which can be maintained for a considerable length of time are between 10,000 and 100,000 oersteds. Professor Kapitza obtained in the laboratory fields of the order of a million oersteds, for very short intervals of time. According to Hale, the magnetic field in the reversing layer of the sun's atmosphere, where the absorption lines in the solar spectrum are produced, is of the order of 50 oersteds.

Later investigations failed to confirm the existence of a constant field of the sun. In 1922 and 1923 the field strength was considerably less than 50 oersteds, and in 1933 no field strength could be detected. More recently, H. D. Babcock has summarized his measurements from 1940 to 1947. At times he recorded a general magnetic field ranging, in the direction given by Hale, between six and 60 oersteds. But at other times the field was practically zero. In Germany, G. Thiessen found in 1945 a magnetic field of the same order as that announced by Hale in 1913. But in



The Zeeman effect in the laboratory (left) and in a sunspot (right) is compared in these photographs from Mount Wilson Observatory.

1947 and 1948 his results were almost entirely negative. There was no magnetic field greater than five oersteds in the expected direction which, according to Hale, nearly coincided with the sun's axis of rotation, but there may have been a very weak field in the opposite direction.

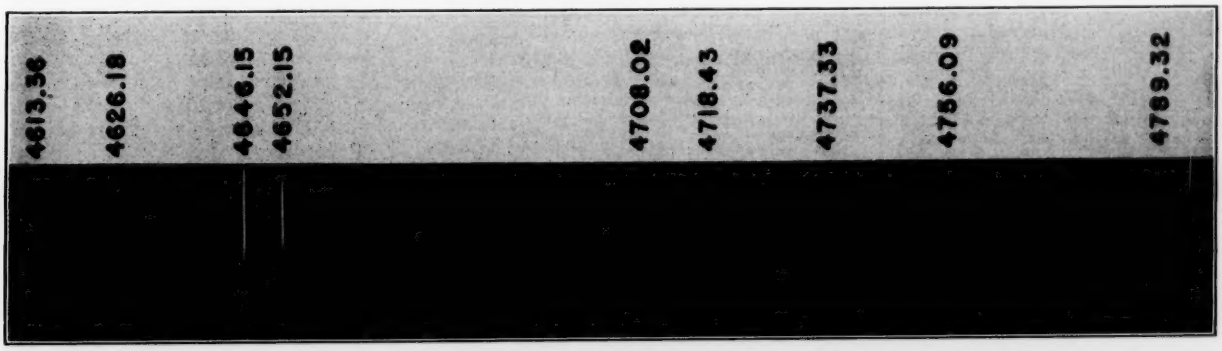
It is thus possible that the magnetic field of the sun is undergoing variations. Thiessen believes that his 1945 observations were based upon too small an amount of material to be certain of this point. At any rate, we must assume that the magnetic field of the sun is either completely variable, or has a small constant value. One of the difficulties in this work is the presence of the large magnetic fields connected with individual sunspots. These fields have lines of force which run as a more-or-less parallel bundle through the spot, at right angles to the surface of the sun. When the spot is near the center of the sun, its lines of force are perpendicular to the lines of the sun's general magnetic field and the polarization should enable us to distinguish between them. But when the spot is near the limb, some of its force lines are parallel to those of the general field, and confusion may arise. It was for this reason that Hale and his associates always preferred to measure the general field during periods of minimum sunspot activity. The sun, however, is never completely quiescent!

Horace Babcock reasoned that if the magnetism of rotating bodies is somehow related to their rotations — an idea which had been suggested by A. Schuster in 1892 — there would be a strong possibility, even a probability, that rapidly rotating stars might show pronounced Zeeman patterns. The rotational velocity of the sun, at the equator, is two kilometers per second. That of a hot star may sometimes be as great as 500 kilometers a second. If, as Schuster and more recently P. M. S. Blackett have suggested, there is a direct relation between the quantity of axial rotation (angular momentum) and a star's amount of magnetism (magnetic moment), then we could expect Zeeman splittings of spectral lines which are 100 or 1,000 times greater than those measured by Hale in the general spectrum of the sun.

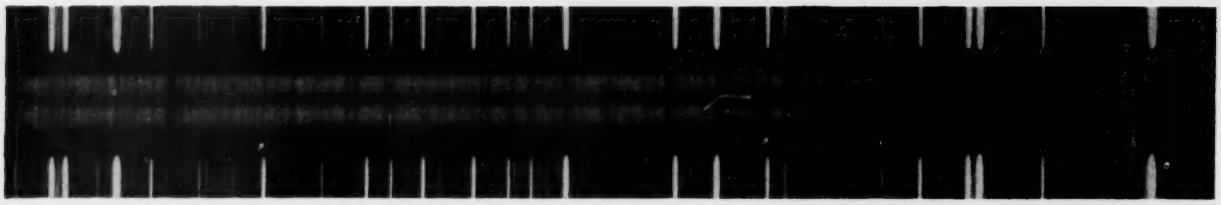
Because of the Doppler effect, however, rapidly rotating stars usually have very diffuse spectral lines.[1] It is only when the axis of rotation happens to lie close to the line of sight that the Doppler effects from all parts of the stellar disk are the same and the spectral lines are sharp and therefore suitable for the test.

Babcock selected several stars of class *A,* and found that the Zeeman effect is unmistakable in 78 Virginis, but is absent in several other stars such as Sirius and Gamma Geminorum. The intensity of the magnetic field of 78 Virginis is about 1,500 oersteds at the pole. The quantity actually measured is an average value of the field strength integrated over the apparent disk of the star. This integration is mathematically simple and leads by means of a short computation to the field strength at the magnetic pole of the star. But it is assumed, and not

[1] O. Struve, "Stellar Rotation," **Sky and Telescope,** VI, 1, November, 1946, page 3.



A portion of the spectrum of neutral chromium, showing sing'e lines in the normal condition that are split into double lines by application of a magnetic field. The central component of the Zeeman triplet is lost because the observations were made along the lines of force. The amount of splitting is not the same for all lines, showing that the simple Zeeman triplet is not always observed; for example, the splitting of the line 4613 is much greater than that for 4756. Some lines show more complex patterns, the nature of which can be explained by the quantum theory. These spectra were made by C. C. Kiess at the National Bureau of Standards.



The spectrum of the star HD 125248, obtained by Horace W. Babcock at Mount Wilson Observatory, between wave lengths 4200 and 4260 angstroms. The comparison (bright-line) spectrum is that of the iron arc. It will be noticed that many of the star lines are slightly oblique, shifted toward the violet side in the lower half and toward the red side in the upper half. This effect appears because in the lower band the red component of the Zeeman pattern was cut off, and in the upper band the violet component was extinguished. If no polarizing apparatus had been employed, all of the spectral lines would have been slightly broadened and there would have been no "tilt" with respect to the comparison lines. The obliquity is particularly striking in several faint lines, such as those marked with the arrows. The strong line near the left end of the star spectrum (at 4205) is that of ionized europium, for this element had its maximum intensity when this spectrum was taken. Half a cycle later the europium line would have been quite weak and the obliquity of the absorption lines would have been in the opposite sense, indicating opposite polarization of the Zeeman components and opposite polarity for the magnetic field. The field strength at the pole of the star was about 7,500 oersteds when the spectrum was made, compared to 36,800 oersteds for Dr. Kiess' chromium spectrum on page 107.

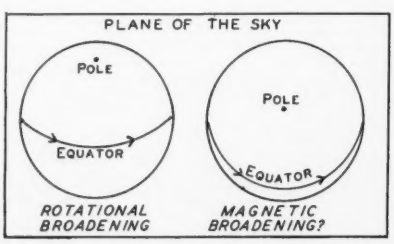
otherwise proved, that the axis is in the line of sight.

Since 1947 Babcock has measured a number of other stars and, strangely, all of those which show large magnetic fields have unusually strong absorption lines of ionized silicon or of other elements, and other peculiar spectral features. Several are known to belong to a class of objects described as *spectrum variables,* in which the intensities of certain spectral lines change periodically. For example, in BD $-18°3789$ the lines of ionized chromium and ionized europium vary in a period of nine days, but with opposite phases; the europium lines are strong when the chromium lines are weak.

Babcock found that the magnetic field of BD $-18°3789$ varies between about $+8{,}000$ oersteds when the Eu II lines are strong and $-6{,}000$ oersteds when the Eu II lines are weak and the Cr II lines are strong. In an ordinary electromagnet, such a reversal of polarity can be obtained when the electric current is reversed. In a permanent bar magnet, a reversal of polarity would suggest a rotation of the whole magnet around an axis that is perpendicular to the long side of the bar. Perhaps the effect observed by Babcock is simply due to the rotation of the star around an axis which is at a considerable angle from the magnetic axis. In the case of BD $-18°3789$, the period of nine days would be the rotational period of the star, and this is not inconsistent with the appearance of the spectral lines. But it is important to note that this would mean that the rotation is rather slow, and that there is no such simple relation as proportionality of angular and magnetic moments.

If this interpretation is correct, then the variation of the line intensities must also be due to the rotation of the star around its axis. A. J. Deutsch has especially emphasized that this would mean a tendency of the atoms of Eu II and Cr II to be concentrated at opposite magnetic poles. A hint as to the possible reason for a migration of different atoms towards the north magnetic pole or towards the south magnetic pole is due to Horace W. Babcock. He suggested that some atoms in stellar atmospheres are paramagnetic while others may be diamagnetic. For example, the elements chromium, iron, silicon, manganese, and hydrogen are all strongly paramagnetic. This means that they tend to arrange themselves in a magnetic field as do the iron filings in the well-known experiment of Faraday. The diamagnetic substances, on the contrary, tend to assume directions which are at right angles to the lines of force. It is possible that the atoms of europium do not have the some paramagnetic properties as does chromium. Hence in such stars as BD $-18°3789$ they may tend to concentrate in the vicinity of the opposite magnetic pole.

More recently Babcock has found three additional stars in which the magnetic field is variable, the most interesting among them being Alpha in Canes Venatici, or Cor Caroli. The magnetic field intensity reaches values of plus or minus several thousand oersteds. This star is the best-known representative of the class of spectrum variables. Its period is 5.5 days, and the variations in the absorption lines have been analyzed by P. Swings and the writer. The changes in the strength of Eu II are closely imitated by changes in other rare-earth elements, especially Gd II and Dy II, and also by the doubly ionized rare earths Eu III, Gd III, Dy III, and so on. But Cr II, Fe II, Si II and H are always strong when the rare earths are weak. Still other elements, notably Mg II and Sr II, remain the same throughout the cycle. The star is not a real spectroscopic binary, but the three groups of elements (Eu II, etc.; Cr II, etc.; and Mg II, etc.) show different velocity curves, roughly opposite in phase for the first two groups, and constant for Mg II. It is perhaps not unreasonable to think of concentrations of europium at one magnetic pole and of chromium at the other, while magnesium is distributed uniformly. As the star turns around its axis, which in this case we must think of as being approximately at right angles to the line of sight, each magnetic pole executes one half of a sine curve when its motion is translated into radial velocity. The other half of the sine curve is invisible because the magnetic pole is then hidden from our vision.



Stars oriented as drawn at the left (in any position angle) can show strong Doppler broadening of their spectral lines if they are in sufficiently rapid rotation, but if they are oriented as at the right, with their poles pointing toward us, then the rotational broadening will be negligible and other effects, such as the magnetic broadening suggested by Babcock, should be observable.

There are now a number of other reasons why, in all probability, we must abandon the supposed correlation between axial rotation and magnetism. One was Babcock's and Thackeray's independent conclusion that the broad hydrogen lines of the white dwarf, Omicron-two Eridani B, are not caused by the Zeeman effect. Blackett had previously suggested that they might have been broadened in fields of several million oersteds. Another, even more convincing reason is that the spectrum variables and other peculiar stars of spectral classes *A* and early *F* usually have fairly sharp lines. There is, of course, a large discovery factor which makes it difficult to find the peculiar spectrum features in stars with rotationally broadened lines. But even so, the probability of finding a star with

(Continued on page 117)

The new observatory at Agnes Scott College, under construction on December 20th. The main entrance is at the right, and the lecture hall on the left.

TUCSON TRAIL

Notes, astronomical and otherwise, concerning points and people of interest along a 6,500-mile journey from Harvard to attend the 82nd meeting of the American Astronomical Society at Tucson.

SPANISH TRAILS once extended across the southern part of what is now the United States from Florida to California. Old forts and missions remain to mark the days of the white man's attempts to tame the wildernesses of the South and the desert lands of the West. An astronomically minded family can today combine "business" with pleasure and glean much of the ways of the different parts of our country even on a limited time budget.

Baltimore, Md. On the top floor of the Enoch Pratt Library building in the heart of the city is the Davis Planetarium, operated by the small but active staff of the Maryland Academy of Sciences. Every Thursday evening the attendance is heavy, and the public is given an opportunity to observe the stars with a telescope on the roof.

A large hall is devoted to astronomy and other scientific exhibits; and the Maryland Academy is doing a real service to the public of Baltimore. Here is the "home" of the annually published and generously distributed "Graphic Time Table of the Heavens."

Chapel Hill, N. C. South of Virginia's lovely hills we completed a day's travel to the Morehead Planetarium of the University of North Carolina. Our tape recorder enabled us to bring back to Boston for further reference a transcription of Dr. Roy K. Marshall's Christmas show, which was so heavily attended as to require a double performance that night, about a week before Christmas. The Morehead building also serves faculty needs for the university and houses the Genevieve B. Morehead art collection. Dr. Marshall's time is hardly his own these days, as he flies north twice weekly to take part in two television programs. His "The Nature of Things" is now a standby with all television fans, and serves to illustrate the tremendous possibilities of television as a medium for bringing scientific facts to the public in a way that can be understood.

Mt. Mitchell, N. C. The Blue Ridge Parkway proved to be all its name and reputation made us expect, but we were prepared for at least a bit of a hike to surmount Mt. Mitchell, highest point east of the Mississippi River. In a way we were disappointed, for the highway continued firm and smooth to within 200 feet of the conifer-clad summit. The resident ranger was just reading the temperature at more than 50 degrees with no snow in sight. Apparently, little mountain hiking needs to be done at Mt. Mitchell, which reminds one of Mt. Wilson with its radio and television towers.

Atlanta, Ga. A few miles to the east of the city is Decatur, where we visited the Calder family. After we were entertained with harp duets, Dr. William A. Calder, head of astronomy at Agnes Scott College, took us over to see construction work on his new observatory. Provision for every need of a smaller research and educational institution seems to have been made, including a small planetarium chamber, a large lec-

Junior attendance at Tucson was high, as this picture, taken in the patio of Yuma Hall during the barbeque luncheon, attests.

Clyde Tombaugh poses at the eye end of his homemade back-yard telescope in Las Cruces, a long-focus reflector which he uses for planetary observing.

ture room, and a fine workshop for amateur telescope makers. The Atlanta Astronomers, under the guidance of Dr. Calder, has developed into a very active amateur group. The observatory will house a 30-inch reflector, with which Dr. Calder expects to carry on a photometric program.

Gulf of Mexico. Rain and warm weather alternated as we toured from Panama City westward to New Orleans, with a stop at Pensacola to view the famous old forts and the naval air station. We were especially privileged to take a tour of a destroyer that is there on active duty — Palomar has simple "gadgetry" compared to that on a modern naval vessel. In New Orleans we learned not to believe road maps of the city when we tried to view muddy Lake Pontchartrain — some of those streets just don't exist for miles! At Baton Rouge we stopped to admire the tall state capital building and then headed west among the swamps and bayous to Texas.

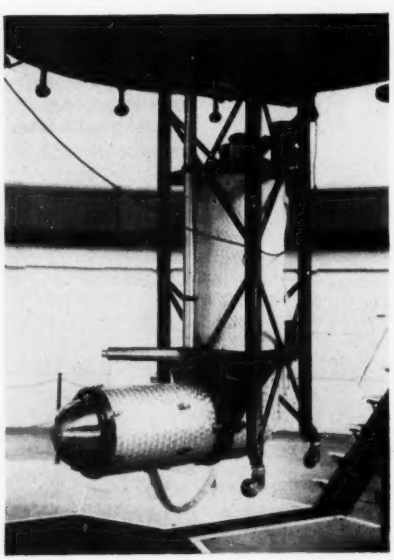
San Antonio, Tex. This city might be the synonym for all that is Texan, and it furnishes an American family many pleasant hours, from shedding silent tears in the Alamo to wandering along the sunken street by the San Antonio River. That evening we crossed the Rio Grande for a step into Mexico at Villa Acuna. A few miscellaneous gifts on a murky Christmas evoked a Christmas spirit that stayed with us as we crossed the Pecos, stopped to see Judge Roy Bean's place at Langtry, and headed for the Davis Mountains.

McDonald Observatory. The density of the astronomical population atop Mt. Locke on Christmas day was very high, reinforced with a party of eight or more from Mexico. This included Dr. Enrique Erro, director of Tonanzintla Observatory, Dr. G. Haro, director at Tacubaya, and Domingo Taboada, leading amateur astronomer of Mexico. Dr. P. D. Jose, resident astronomer at McDonald, is most hospitable to everyone, and our family found it hard to leave the company of his. More Yerkes astronomers were on hand than we might have seen at Wisconsin headquarters, and that evening we enjoyed visiting with the observer for the ensuing month, Dr. Otto Struve, who began his night's work at the 82-inch with a spectrogram of U Cephei.

At McDonald has been set up the wide-field camera that many years ago began a survey of the Milky Way on plates measuring 20 by 24 inches at the private observatory of the late Dr. G. W. Cook, at Wynnewood, in the outskirts of Philadelphia. This instrument, on a five-year loan from the University of Pennsylvania, will complete the Milky Way survey under the favorable skies of Mt. Locke before being put to other work. Also in operation is a 13-inch Cassegrainian reflector to which Dr. W. A. Hiltner has attached a photoelectric photometer. The mirror of this instrument was made by Bernhard Schmidt.

The state-operated Indian Lodge, just off the road up the mountain, has fine accommodations amid beautiful surroundings. Our admiration of Texas scenery closed with Guadalupe Peak, highest point in the state, which we passed at sunset and watched grow dim in an amazing spectrum that rose ahead of the earth's shadow to the east, more striking than we had ever seen it before.

Las Cruces. Via El Paso, where unsurpassed Christmas decorations adorned the central square, we reached Las Cruces, a "rocket boomtown" along with Alamogordo. Clyde Tombaugh, discoverer of Pluto, is in charge of the optical equipment for observing and recording missile firings at White Sands Proving Ground. With his family, he drove us on a truly inspiring trip to White Sands National Monument, over 50 miles from Las Cruces. That evening we had opportunity for a rare view of the moon through the 17-inch reflector of Dr. Paul Engle, of the New Mexico College of Agriculture and Mechanic Arts.



The two-prism spectrograph attached to the 82-inch McDonald reflector.

Dr. Edwin F. Carpenter, director of Steward Observatory, and host to the astronomers at the Tucson meeting.

The Harvard meteor stations near Las Cruces are in charge of Richard E. McCrosky, with the assistance of Philip S. Carroll and Peter Cioffi. Mr. Carroll was our guide on an after-dark excursion to inspect the Dona Ana station. There, in the vastness of New Mexico, meteor observing by photography is bringing hitherto unattainable data down from the heights where the meteors live their brief lives.

Deming, N. M. Have you ever stayed at the Skytel Motel at Deming, the last place on the road going west out of town? We recommend it, having our curiosity satisfied by learning that the name was inspired by an airfield rather than by the cable address of this publication.

Tucson, Ariz. One literally "coasts" down into the winter resort that is Tucson. The days of the meeting proved ideally warm by day and cool at night, and the tropical palms, orange trees, and stucco buildings made a pleasing atmosphere for the astronomical gather-

ing. Flagstaff seemed way up north, and they said it was much colder there.

Fitting well in the Tucson setting is the Steward Observatory of the University of Arizona, pictured on the front cover. It houses a 36-inch reflector with which photoelectric work is being done by Director Edwin F. Carpenter and his assistants. Operation of the photometer was demonstrated to the visiting astronomers during the meeting.

Among the Arizona State Museum exhibits that were inspected during a reception were displays of the work on tree-ring chronology of Dr. A. E. Douglass and Dr. Edmund Schulman. Dr.

Dr. A .E. Douglass, of the University of Arizona, was formerly director of the Steward Observatory.

Douglass, pioneer in this work since 1901, has completed a tree-ring calendar from the year 11 A. D. to the present. His instrument for cycle analysis, the cyclograph, has been applied to the reading of solar activity cycles as well as to climatic and tree-ring cycles.

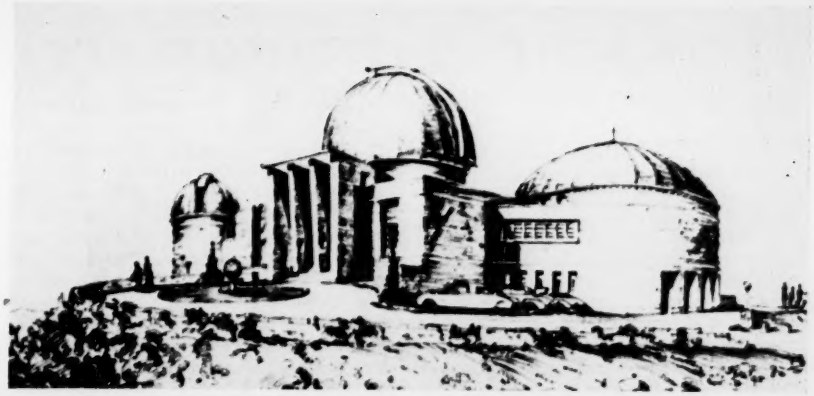
At the society dinner on Friday evening, December 30th, it was announced that the Annie Jump Cannon prize has been awarded to Dr. Helen Sawyer Hogg, of David Dunlap Observatory,

THE INDEX TO VOLUME VIII

of Sky and Telescope is now on sale. This and the indexes to previous volumes cost 35 cents each, in coin or stamps, or included in the payment of the renewal of your subscription.

BACK ISSUES are available for most numbers. Some are in bound form at $6.50 each volume, postpaid.

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Mass.



An architect's drawing shows the proposed building for the new observatory for Vanderbilt University. The dome at the right is for use with a projection planetarium instrument.

University of Toronto. Dr. Hogg will receive the prize at the next meeting of the American Astronomical Society, in June at the University of Indiana at Bloomington. The December, 1950, meeting will be held at Haverford, Pa.

Two symposia made up a considerable portion of the technical program. One of these was chiefly a series of progress reports on current work with the large Schmidt telescopes at Tonanzintla, Cleveland, Harvard, and Palomar. Perhaps most interest centered in Dr. Walter Baade's discussion of the sky survey with the 48-inch Schmidt on Palomar Mountain. The other symposium, "Some Problems of Dwarf Stars," will be briefly described in "American Astronomers Report," in a future issue.

Cactus and Cave. Various trips to points of interest around Tucson were scheduled for the last day of the year. Fortunately, Saguaro National Monument lay nearly on our way home. The cactus forest in late afternoon is indeed an inspiring sight, and a good place for color film. And farther on we took time out to descend into Colossal Cave, operated by Pima County. Young folk are especially impressed with the darkness of the depths when the guide turns out the lights several hundred feet inside the earth.

Odessa, Tex. A few hours were spent looking for and inspecting the meteor crater in the oily fields near Odessa. As a crater it is not very impressive except to those with astronomical interests, but it is quite accessible several miles west of town on the south side of the railroad and perhaps a mile from the main highway. The crater is in the midst of new oil drillings, and it is in need of restoration from prewar diggings in search of meteoritic material.

Ft. Worth, Tex. Amateur astronomer Oscar E. Monnig, editor of the late Texas Observers' *Bulletin*, that evening told us of his early visits to Odessa and to other meteorite craters. Searching for meteorites he has spent much time and gasoline, sometimes to be rewarded by finding the real thing. Ft. Worth and Dallas are both growing rapidly as far as astronomical societies and astronomy for the public are concerned. The Ft. Worth Children's Museum now owns a Spitz planetarium.

Nashville, Tenn. Sloshing through rain, fog, mud, and over narrow roads through eastern Texas, Arkansas, and western Tennessee, we thought that New Englanders would find snow and ice easier going and that we should have taken the northern route. We stopped to have lunch with Dr. and Mrs. Carl A. Seyfert, of Vanderbilt University Observatory. The present observatory is located on the campus.

Dr. Seyfert is very busy with plans for a new observatory situated in a hilly region a few miles south of Nashville. Already much of the building and some instrumentation have been accounted for, and the plans even include provision for a planetarium. The Barnard Astronomical Society in Nashville is active in supporting Dr. Seyfert's program of expansion, both in the teaching and study of astronomy at Vanderbilt.

The Final Breeze. Ninety-six hours elapsed from Tucson to Boston, 2,900 miles, but the last lap from New York City was done in an easy and restful 4½ hours after crossing the George Washington Bridge at 6:00 p.m. New England seems to have some good roads of its own now: Prospective delegates to the Wellesley convention in July, please note! C.A.F.

Further information on some of the persons and places visited in this story can be found in the following *Sky and Telescope* articles:

Maryland Academy: "Trail Blazing with Spitz Planetariums," January, 1949, page 66.

Morehead Planetarium: "The Morehead Planetarium," Roy K. Marshall, August, 1949, page 242.

White Sands: "Optical Instrumentation for Guided Missiles," Dirk Reuyl, October, 1949, page 299.

Harvard meteor stations: "The Harvard Photographic Meteor Program," Fred L. Whipple, February, 1949, page 90.

Amateur Astronomers

League Convention Program and Reservation Information

AS ANNOUNCED last month, the 1950 convention of the Astronomical League will be held July 1-4 at Wellesley College, Wellesley, Mass., 15 miles west of Boston. The program to date, subject to later revision and additional details, accompanies this announcement.

Program Notes. Amateurs wishing to take part in the program should state the nature and topic of proposed talks to Rolland R. LaPelle, 54 Fernleaf Ave., Longmeadow 6, Mass., as he heads the program committee. The title and a brief synopsis of each paper must be in Mr. LaPelle's hands by April 1st, and the complete paper must be available, with slides or illustrations if required, by May 1st. Talks are limited to 10 minutes each.

The dinner on Monday evening, July 3rd, in the Great Hall of Tower Court, will be the occasion for a talk by Dr. William A. Calder, who will describe the new observatory at Agnes Scott College and discuss amateur activities in Atlanta and vicinity. On Sunday evening, after supper, the panel of experts is expected to include such well-known Harvard astronomers as Dr. Harlow Shapley, the Gaposchkins, and Dr. A. J. Deutsch. In the convention schedule, time has been provided between sessions for general recesses, and there is time for some recreation each day.

Outdoor School for Observers. Three nights may be devoted to observing if weather permits. Wellesley is sufficiently far from Boston to be little affected by city lights, and the large area of the wooded campus further aids observing conditions. The moon is past full, rising about 10:00 p.m. The school for observing is expected to include demonstrated instruction on how to observe the sun, variable stars, double stars (with the Whitin Observatory 6-inch telescope equipped with a position micrometer), planets, nebulae and clusters, and the moon.

Exhibits. Photographs, charts, and diagrams may be sent in advance to the undersigned to insure their hanging in a suitable location. All instruments, devices, and accessories, however, must be brought to the convention, and space will be provided to set these up. It is expected that many telescopes will be needed for the evening observations, so bring your instruments if you can.

Field Trip. The field trip late Tuesday forenoon and afternoon will have as its main objective the Oak Ridge station of Harvard Observatory, near Harvard, Mass. Inspection of the 61-inch Wyeth reflector, the 24-33-inch Jewett Schmidt camera, and other instruments will be possible. Lunch will be taken en route. The return trip will be to Cambridge and Boston via historical Concord and Lexington. The final point of interest will be the new Boston Museum of Science, at Science Park, where there is a Spitz planetarium. A bus can be provided for the Oak Ridge tour if necessary. Those traveling by train will be transported to the Harvard Square subway or to South Station if desired.

Accommodations and Registration. Excellent facilities in Tower Court at Wellesley College are available, but we must furnish to the college by April 1st a guarantee of the minimum number expected to be in attendance. Therefore, all delegates and visitors are urged to forward reservations before that date, accompanied by a deposit ($5.00) equal to one day's meals and lodging. The deposit will not be returnable unless the canceled reservation is taken up by someone else after the minimum guarantee has been met. It is expected that requests for return of deposit owing to sudden illness or other emergency preventing one's attendance at the convention will be honored, but no refunds can be made until after the convention has taken place.

This early publication of the convention program should enable a good portion of those who are coming to send their reservations to the undersigned by April 1st. This does not mean that reservations will not be accepted after that date, but preference will be given to the earliest applications. As the college is host to a number of conventions during the summer and has commitments far in advance requiring preparation of quarters, it is very unlikely that another building can be assigned to us to handle a great number of last-minute reservations.

The accommodations at Wellesley College will include three nights lodging beginning Saturday evening, July 1st, and ending Tuesday morning, July 4th; three meals Sunday, three meals Monday, and breakfast Tuesday. The basic charge for this is $15.00 per person, plus $1.00 for the convention registration fee. Therefore, each person who registers before April 1st, sending in $5.00 deposit, will have a balance payable upon arrival at the convention of $11.00. There will be no rebate nor reduction for nights not spent at the college or meals not taken, as the service will be provided anyway. Checks and money orders should be made payable to the Bond Astronomical Club.

Registration (with deposit) made during the months of April and May, after our guarantee has been stated, will be $16.50; during June add 50 cents more, total cost $17.00; and those arriving at the convention without advance reservations will be

Saturday, July 1

3:00 to 5:00 p.m.	Informal Open House at Harvard Observatory in Cambridge, conducted by members of the Amateur Telescope Makers of Boston and the Bond Astronomical Club.
6:00 p.m.	Informal gatherings for supper at Howard Johnson's in Harvard Square, Cambridge; also at Wellesley Inn for those arriving directly in Wellesley.
6:30 p.m. and on.	Registration for rooms at Tower Court, Wellesley College.
7:45 to 9:00 p.m.	"Celestial Scenery," a showing of astronomical and color pictures by Dr. John C. Duncan, director of Whitin Observatory.
9:00 to midnight.	Open House, Whitin Observatory. Outdoor School for Observers.

Sunday, July 2

8:15 to 8:30 a.m.	Breakfast served.
9:00 to 9:30 a.m.	Regional meeting, Northeast Region, Astronomical League.
9:30 to 10:45 a.m.	Opening convention session. Roll call by member organizations.
11:00 a.m. to 12:30 p.m.	Summary of observational work by AL members, with reports from individual societies.
12:45 p.m.	Group photograph.
1:00 p.m.	Dinner. Fill out questionnaires for Panel of Experts.
2:00 to 3:30 p.m.	Variable and Double Star Section.
3:45 to 5:00 p.m.	General subjects.
5:00 to 6:00 p.m.	Swimming and recreation period. Solar observing.
6:00 p.m.	Sunday supper.
7:30 to 9:00 p.m.	Panel of Experts.
9:00 to midnight.	Outdoor School for Observers.

Monday, July 3

7:45 to 8:15 a.m.	Breakfast served.
9:00 to 10:00 a.m.	Business session. Election of officers. Site for 1951 convention to be considered.
10:15 a.m. to 12:15 p.m.	Instruments Section.
12:30 p.m.	Lunch.
1:30 to 3:15 p.m.	Solar, Aurora, Occultation, and Meteor Observing.
3:30 to 5:00 p.m.	Lunar and Planetary Observing.
5:00 to 6:00 p.m.	Swimming and recreation period. Solar observing.
6:15 p.m.	Dinner. Address by Dr. William A. Calder, Agnes Scott College, Decatur, Ga.
9:00 to midnight.	Outdoor School for Observers.

Tuesday, July 4

7:45 to 8:15 a.m.	Breakfast served (last meal at Wellesley College).
9:00 to 9:30 a.m.	Northeast regional meeting.
9:30 to 10:30 a.m.	Final business session; awarding of exhibit prizes.
11:00 a.m. and on.	Field trip to Harvard's Oak Ridge station and points of interest in the Boston area.

charged a total of $17.50, including registration fee.

The accommodations are mostly single rooms, but there are some rooms containing two single beds. Please specify which type of room you prefer. Wherever possible, two or more persons traveling together will be placed in adjoining quarters, except that there will be areas assigned to single men and to single women, respectively.

It may be that the Wellesley College accommodations will be filled to capacity, in which event all reservations received thereafter will be returned and information given concerning accommodations at the nearby Wellesley Inn, a reasonable and comfortable hostelry.

An important point to note concerning the cost of the convention is that there is no special charge for a banquet. Families are encouraged to attend the convention, but no special reduction in price can be made for children — the Wellesley College charges are already just sufficient to cover costs. Swimming in Lake Waban is permitted from 10:00 a.m. to 6:00 p.m., with lifeguards on duty. An optional charge of $1.00 per person for swimming privileges covers the entire period of the convention.

Transportation. The main line of the Boston and Albany railroad from Boston to Springfield and points south and west runs through Wellesley, but most trains stop either at Framingham, seven miles west, or Newtonville, seven miles east of Wellesley. Arrangements will be made to meet some important trains from the West, and taxi service from either station is available. Those coming by train to South Station, Boston (via Boston and Albany or New Haven railroads), en route to Harvard College Observatory for the first event on the program, take the subway to Harvard Square, thence the Huron Avenue bus five minutes to the observatory. Cars will transport them and luggage from the observatory to supper and to Wellesley that evening. There will be ample parking space for automobiles on the campus. Local amateurs will assist in providing needed automobile transportation.

All signs point to the Wellesley convention as being one of the best in Astronomical League history. We wish to urge all amateur and professional astronomers to give early consideration to attending and taking part in the varied program. Please send in your reservation at once if you plan to come, as the early receipt of reservations is essential to the success of the convention.

CHARLES A. FEDERER, JR.
Chairman, Wellesley Convention
Harvard College Observatory
Cambridge 38, Mass.

THIS MONTH'S MEETINGS

Chicago, Ill.: The Burnham Astronomical Society will meet on Tuesday, March 14th, in the Chicago Academy of Sciences auditorium at 8 p.m. There will be the usual reports on the March evening sky, observations, and telescope making. The evening's lecture will be by John Sternig, director of science in the Glencoe public schools, on "Rockets and Space Travel."

Cleveland, Ohio: "The Satellites of the Solar System" will be discussed by Dr. Daniel Harris, III, of the Warner and Swasey Observatory, at the meeting of the Cleveland Astronomical Society on March 10th, 8 o'clock at the observatory.

Public nights will be held at Warner and Swasey Observatory on March 30th and 31st, when a lecture will be given on "The Sun's Family," at 8:00 p.m., followed by observing. Reservations may be made through the Case Institute of Technology, Tyler 1-1000.

Dallas, Tex.: On March 28th, at 8 o'clock in the Dallas Power and Light auditorium, the Texas Astronomical Society will hear talks by members with film-strip illustrations, will hold election of officers, and view a scientific film.

Detroit, Mich.: At the March 12th meeting of the Detroit Astronomical Society, Dr. Dean B. McLaughlin, of the Observatory of the University of Michigan, will speak on "The Borderland of Astronomy and Geology." The meeting is in State Hall, Wayne University (entrance on 2nd Ave.).

Geneva, Ill.: At the March meeting of the Fox Valley Astronomical Society, Dr. Gilbert Raash, of the State Geological Survey, will speak on "The Geologic History of Chicagoland." The meeting is at the Geneva City Hall on March 7th at 8 p.m., and is open to the public.

Indianapolis, Ind.: "Our Milky Way Galaxy" will be discussed by Dr. Harry E. Crull at the March 5th meeting of the Indiana Astronomical Society, 2:15 p.m. at Cropsey Hall.

New York, N. Y.: Dr. Lyle B. Borst, of the Brookhaven National Laboratory, will speak on "Celestial Atomic Bombs" at the meeting of the Amateur Astronomers Association on March 1st, held in the American Museum of Natural History (77th St. entrance), at 8:00 p.m.

Pittsburgh, Pa.: On Friday, March 10th, at 8:15 p.m. in the Buhl Planetarium, R C. Bossart will present an illustrated lecture on "Cave Exploration," before the Amateur Astronomers Association of Pittsburgh.

St. Paul, Minn.: A. T. Adams will talk on "Precession of the Equinoxes," before the St. Paul Telescope Club on Wednesday evening, March 8th, at 8:00 p.m., Carnegie Science Hall, Macalester College.

Stamford, Conn.: On March 17th the Stamford Amateur Astronomers will hear Edwin M. Bailey, Jr., speak on "Radio and Radar Astronomy." The meeting is at the Stamford Museum at 8 p.m.

Washington, D. C.: The National Capital Astronomers will have as guest speaker at its March 4th meeting Dr. John P. Hagen, of the Radio Division, Naval Research Laboratory, whose topic will be, "Radio Emission from the Sun." The meeting is at 8:00 p.m. in the Commerce Building auditorium.

Yakima, Wash.: "Principles and Practice of Telescope Making" is the theme of the March 13th meeting of the Yakima Amateur Astronomers, at 8:00 p.m., in the Chamber of Commerce building.

AMATEUR NEWS FROM HERE AND THERE

Officers for 1950 were elected by the **Los Angeles Astronomical Society** as follows: president, Tom Cave; vice-president, Dr. Homer King; recording secretary, Robert Branch; treasurer and business secretary, George Shuster. Vice-president King will also have charge of the society's shops at the Griffith Observatory.

Thomas Cragg, chairman of the observing section, continues in that capacity for the third straight year. The society's outgoing president, Walter de Palma, under whom the first western regional conference of amateur astronomers was staged in 1949, remains on the board of directors, as does Harry L. Freeman, retiring treasurer.

At its annual meeting on January 9th, the **Detroit Astronomical Society** honored Mrs. Margaret Back, its president and secretary for three years. For seven years before that she was secretary and program chairman, and during those 10 years she never missed a meeting. Mrs. Back was also secretary of the Astronomical League until last September. At the meeting, she was unanimously elected president emeritus of the Detroit Astronomical Society, and was presented with a small inscribed silver tray.

New officers are C. S. Johnson, president; J. A. Mote, secretary; Mrs. W. R. Bryant, assistant secretary; and Mrs. Paul Roper, treasurer. Mrs. Back will continue to act as program chairman.

The **Phoenix Observatory Association** was organized on November 15, 1948, chiefly through the efforts of Professor Amos Hoff, head of engineering at Phoenix College. Its chief project is completion of a 24-inch mirror for the Phoenix Observatory. Funds were furnished by the college, and the object is to provide the citizens of Phoenix with an observatory, to do serious work within the group, and to provide an instrument for the college astronomy students.

The club gathers twice a month for business meetings, and several times a week for work sessions. The secretary-treasurer is Paul E. Griffin, 1708 S. 3rd St., Phoenix, Ariz.

Darling Observatory, at the Duluth branch of the University of Minnesota, is open the third Friday evening of each month, under the direction of Dr. C. B. Lindquist. The **Darling Astronomy Club** meets there on the 1st and 3rd Friday evenings. The secretary-treasurer is Mrs. A. J. Lynch, 1911 Wisconsin Ave., Superior, Wis.

The **Richmond Astronomical Society** was organized last October 15th, at Richmond, Va. Its president is Wilbur Stone; vice-president, Beaufort S. Ragland; secretary-treasurer, Lillian Sievers. There are some 20 members, about one half of whom have their own telescopes, with other instruments in the making. Correspondent Ragland's address is 2000 Barton Ave., Richmond, Va.

Utica Amateur Astronomers is the name of a new society recently formed at Utica, N. Y. The group has voted to join the Astronomical League. Further information may be had from John Zimm, 103 Richardson Ave., Utica, N. Y.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 82nd meeting of the American Astronomical Society at Tucson, Ariz., in December. Complete abstracts will appear in the Astronomical Journal.

Double Blast in Arizona

COMPARISON of meteorites found on the slopes of the rim of Meteor Crater in Arizona with fragments found several miles away leads Dr. H. H. Nininger, of the American Meteorite Museum, to some detailed proposals concerning the nature of the explosion of the giant meteorite that formed the crater.

It has long been known that all of the slope finds have been small (with a few exceptions), mostly less than two pounds in weight, the average being about one half a pound. The large specimens, between 10 and 1,000 pounds, have been found in various locations one to six miles from the crater pit and on all sides of it. Small specimens were often found in the outlying areas, and now Dr. Nininger has made a detailed comparison of their structure with the small fragments found on or near the rim. He has been assisted by a grant from the American Philosophical Society.

The Widmanstaetten pattern revealed by etching normal nickel-iron meteorites shows up well for all specimens from the outlying points, whether they be large or small. On the other hand, in some 200 small specimens from the crater rim that have been cut and studied during the past 25 years, the patterns seem to have been destroyed by heat. In the absence of any known mechanism whereby the patterns could be destroyed since the time of the fall, Dr. Nininger attributes the above difference to the effects of a twofold disruption of the original meteorite. First there was a shattering upon contact with the firm-textured limestone beds of the region and seconds later a true explosion in the depths of the crater.

The shattering was facilitated, he believes, by the irregular distribution in the original meteoritic mass of two brittle minerals, schreibersite and cohenite, neither of which is known to exist in terrestrial rocks. Both of these minerals are as brittle as window glass, and the outer layers of the meteorite easily fractured as soon as the block of air in front of it was stopped by the earth's surface. The outlying fragments came from this first phase of the meteorite's disruption, and were subjected to no great heat.

The material which buried itself deep in the earth and then exploded as its kinetic energy was transformed to heat was altered by the high temperature, obliterating the crystalline structure that produces the Widmanstaetten lines.

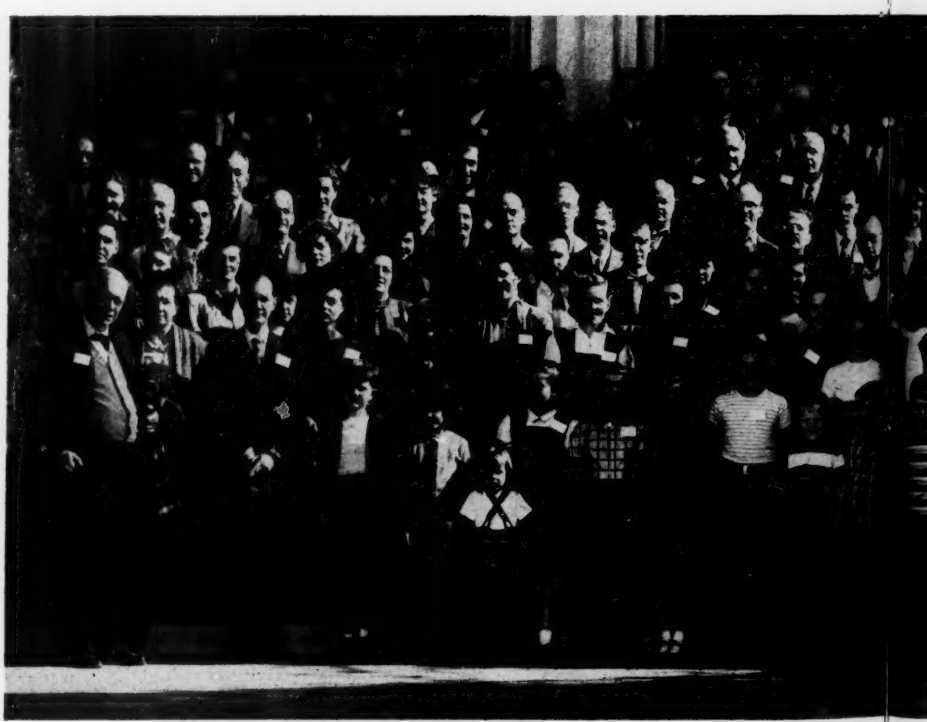
In making this proposal, Dr. Nininger stated objections to the possibility of the outlying fragments arriving as companions or satellites of the original main mass. Such fragments would have buried themselves very deep in the soil, and erosion has proceeded too slowly to have uncovered them in the time since the fall. Almost all present finds are made on the ground surface or a few inches deep.

The distribution of meteorites around the crater also favors belief in a single meteorite, for it is known to have come in at an angle at least 45 degrees from the vertical. If companion meteorites came with it they would have fallen in an elliptical pattern on the Arizona plateau. The large masses are found all around the crater to considerable distances, with no preferential direction.

Very Hot Stars

PLANETARY NEBULAE are known to receive their energy to shine from very hot stars located at their centers. Dr. Thornton Page, of Yerkes Observatory, described how in the case of these stars, surrounded by vast spherical shells of glowing gas, we have a sensitive method of determining surface temperatures, using the far ultraviolet light, which is converted to visible light in the nebulae by the well-known process of fluorescence. From the intensity of the *visible* light of the nebula we have a measure of the amount of *far ultraviolet* energy emitted by the central star, and this, in turn, depends on the star's surface temperature. The visible light of the star is also directly related to its temperature.

Therefore, by measuring the intensity of the nebula's light and comparing it to the star's light we can determine the star's surface temperature. In the past, the emission lines of the nebula's spectrum have been used, first by the Dutch astrophysicist, Zanstra, but the resultant values are theoretically much too low. A variation of the Zanstra method has recently been proposed by the German astrophysicist, Karl Wurm, whereby the fainter continuous emission of the nebula is compared with the star's spectrum. Wurm's method has been applied by Dr. Page to three planetary nebulae, confirming the earlier temperatures of the central stars in two cases, and leading to the very high figure of over 150,000° Celsius for the third. This star is the nucleus of the well-known Ring nebula in Lyra, and it has, therefore, one of the highest surface temperatures known in the universe.



Members and guests at the 82nd meeting of the American Astronomica

Polarization Theory

ELONGATED PARTICLES of dust oriented along certain planes over vast regions of space have been proposed to explain the polarization of starlight observed in recent years by Dr. W. A. Hiltner, of Yerkes and McDonald Observatories, and Dr. John S. Hall, of the United States Naval Observatory. Such orientation has seemed to call for the action of a magnetic field on particles containing iron and existing at very low temperatures, so that their random motions would not produce so many collisions between particles as to ruin the orientation.

For the separate purpose of explaining the origin of cosmic rays, Dr. Enrico Fermi has proposed interstellar magnetic fields of about 3×10^{-5} gauss. The astronomical observations favor uniformity of the direction of the field over regions as large as 300 light-years in the galaxy.

Dr. Jesse L. Greenstein, of Mount Wilson and Palomar Observatories, and Professor Leverett Davis, Jr., of California Institute of Technology, have collaborated on a theory that permits the observed polarization to take place in such hot regions as those at the 10,000° absolute known for some of the hot gases associated with the early-type stars in the Orion nebula. At these high temperatures, a dust particle suffers a collision with a hydrogen nucleus once a day and acquires a rotation of perhaps a million spins per second in the average collision. After about a million such random collisions, the particle may be spinning a billion times per second.

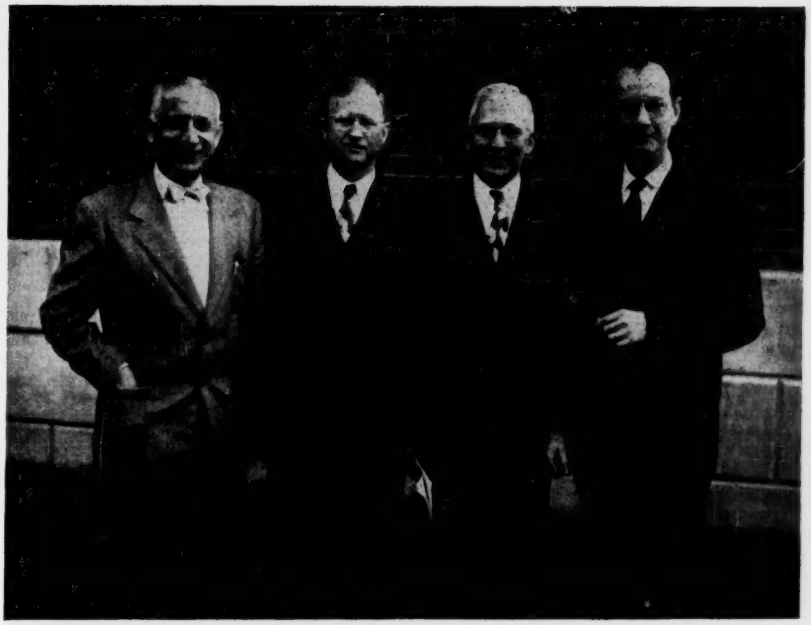
The new theory supposes that the interstellar grains, probably crystalline in structure, are not round, but are elongated or at least irregular in shape. Such particles, although spinning rapidly, will appear elongated from certain directions, just as a football does whether kicked or thrown, depending upon who views it. An end-over-end kick looks circular to the spectators, but elongated vertically to the receiver. Particles of any shape tend to spin about the shortest axis, as in the case of the end-over-end kick of a football.

A small amount of iron is necessary to make dust particles susceptible to magnetic field action. From one to five per cent of an interstellar grain is probably metallic, Dr. Greenstein believes, and this is mostly iron. This would make the particle paramagnetic, that is, subject to magnetic effects.

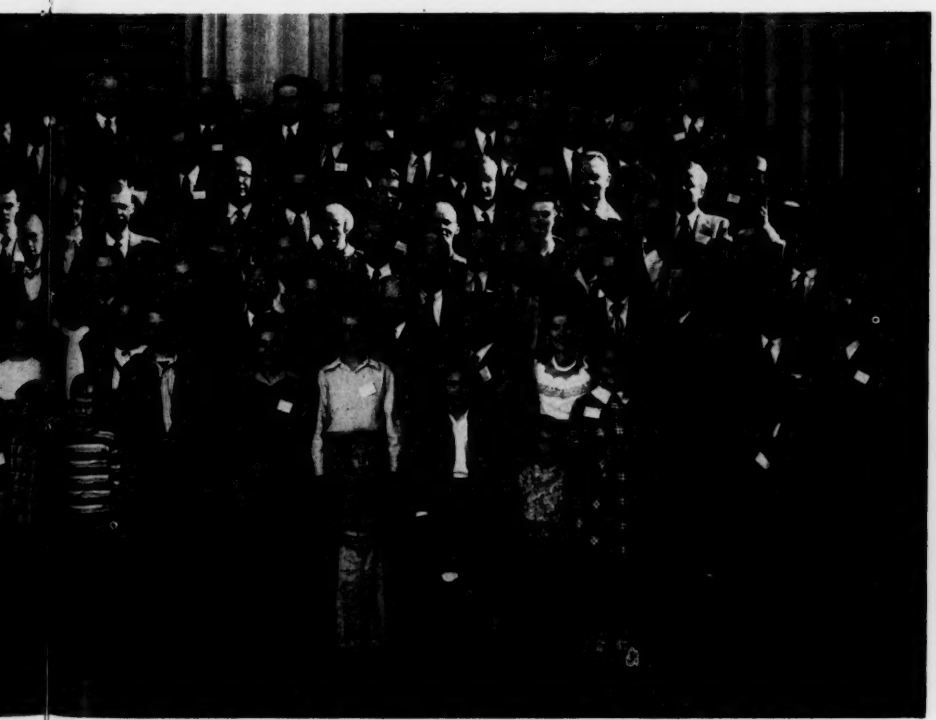
The magnetic field would tend to line up the axes of rotation of the spinning particles, and light passing through such a region would be polarized by the "elongation" of the particles as seen by the eventual receiver of the light. Obviously, not all of the particles will be oriented properly, so the polarization will be only partial, as already determined by the observations of Hiltner and Hall.

Dr. Greenstein summed up by saying, "Thus we picture slightly paramagnetic dust grains as spinning rapidly around axes which are being disoriented by collisions with hydrogen atoms while the magnetic field patiently tries to keep the axes oriented."

In the absence of this theory, Dr. Greenstein stated that magnetic fields 10 times as strong as proposed by Dr. Fermi would be required, the particles would have to be ferromagnetic and at a temperature of only 10° absolute.



Officers of the American Astronomical Society include, le't to right, Dr. J. J. Nassau, treasurer; Dr. C. M. Huffer, secretary; Dr. A. H. Joy, president; and Dr. F. L. Whipple, vice-president. The other vice-president, Dr. Dirk Brouwer, was at the AAAS meeting in New York.



Astronomical Society at the University of Arizona, December 28-31, 1949.

NEWS NOTES

By Dorrit Hoffleit

ON THE MOON

What's on the moon? The barrenness of that orb is a challenge to many astronomers, amateurs, and would-be space travelers. Science Service recently issued two releases on the subject. In one, the discovery by the research chemist, Jack De Ment, of gold and silver in tektites found on an island in the Java Sea prompted speculation about occurrence of these precious metals on the moon. In 1946, H. H. Nininger advanced the hypothesis that tektites are fragments of the lunar surface — chips flung from the moon when it was struck by high-velocity meteorites.

The other report concerns some observations of the October lunar eclipse. Walter Haas, of the Institute of Meteoritics, University of New Mexico, observed changes before and after eclipse in two craters out of four specifically examined. Suspected of changes during past eclipses is the floor of Eratosthenes, and it was observed for several months before the eclipse and compared with another area of equal brightness. During the eclipse, 15 square miles of dark area showed definite brightening, and this persisted for several hours after totality. In Grimaldi the relative brightness of two spots likewise changed, these latter being partially confirmed by other observers. In the *Strolling Astronomer,* edited by Haas, James C. Bartlett, Jr., discusses in a series of articles the factors involved in the possibility of vegetative organisms on the moon. He believes the observational evidence favors some sort of lunar plant life.

COMMUNICATION WITH OTHER PLANETS!

In the *Journal* of the British Interplanetary Society, we read an amusing account of a session the secretary had in October, 1949, with a member of the public press. The reporter brought with him "evidence" that the U. S. Navy had succeeded in sending a rocket to Venus on January 14, 1947. It was difficult to convince the reporter that such an event would not have gone so long unheralded. The printed "evidence" was an article, "The Aphrodite Project," in *Astounding Science Fiction.* Alas that even the word "fiction" in the title of the journal is insufficient to stall credulity.

Alas, too, that the story was pure fiction. For we have an Associated Press clipping telling us that a prize of 100,000 francs awaits the first one "who will find the means of communicating with a heavenly body." Sixty years ago Mme. Guzman in France established the Prix Pierre Guzman in the name of her son. It is to be awarded by the French Academy of Sciences, which must sift through all the applications, most of which resemble Jules Verne science fiction. The prize is somewhat restricted: by "communicating with the heavenly body" the donor said, "I thus mean by making signs to a heavenly body and receiving an answer to those signs." She also added that the planet Mars was specifically excluded because "It seems sufficiently known"! The 100,000 francs nowadays amount to only about $225 in American money, but think of the prestige!

ONE HUNDRED YEARS OF THE "ASTRONOMICAL JOURNAL"

One hundred years ago last November the first number of the *Astronomical Journal* was published. The preamble then written by its founder and editor, Benjamin Apthorp Gould, was reprinted on the occasion of the anniversary. Gould wrote, "Such a work ought to support the dignity of a pure science, striving for the extension of the realm of human intellect; it should furnish the means of publication and prompt dissemination of discoveries and researches; and should promote harmony among astronomers, laboring for a common end — while it furnishes an opportunity for the manly expression of differences of opinion."

In the pages of the *Astronomical Journal* one finds many illustrious names of American astronomy, Gould, Benjamin Peirce, Simon Newcomb, E. E. Barnard, W. W. Campbell, Frank Schlesinger, to name but a few out of the past. Contrary to Gould's hope and expectation, publication was not continuous. In 1941 the ownership was transferred to the American Astronomical Society, but with the continued support of the Gould Fund. The *Astronomical Journal* looks forward to its second century of activity, again with the hope and expectation that the ideals of its founder will be continuously realized.

In the CURRENT JOURNALS

The Milky Way, by Bart J. Bok, *Scientific American,* February, 1950. "While we know the general shape and outline of the system, we have only begun the task of filling in the details."

The Genesis of Cosmic Radiation, by Serge A. Korff, *Physics Today,* January, 1950. "The amount of cosmic ray energy arriving at the earth somewhat exceeds the total luminous energy arriving from all the stars and nebulae in the universe." Many theories have been proposed to account for the origin of the cosmic rays. "Each possibility has its enthusiastic champions, but as yet no conclusive experimental test has been proposed."

Spectroscopic Binaries, by Otto Struve, *Popular Astronomy,* January, 1950. The address of the retiring president of the American Astronomical Society, read at the Tucson meeting in December. Starting with an appeal for a stand on the freedom and internationalism of our science, the author proceeds to the history and development of the science of the stars that are known to be double from the peculiarities of their spectra, and describes how the variations in the spectra are interpreted.

BOOK PRIZES

The British Interplanetary Society wishes to encourage its members to submit articles for possible publication in its *Journal.* An essay competition has been announced. Authors may choose any one of the following topics: "Why Interplanetary Travel Interests Me," "How I Believe Man Will Reach the Moon," and "What I Think the British Interplanetary Society Should Do to Hasten the Conquest of Space." Prizes will consist of books on ballistics, rocketry, and astronomy. The astronomical books are the Harvard books on astronomy, and *The Atmospheres of the Earth and Planets,* edited by G. P. Kuiper.

OPTICAL SOCIETY MEETING

The winter meeting of the Optical Society of America will be held at the Hotel Statler, in New York City, on March 9-11. The meeting is open to all interested persons, and non-members may secure copies of the program from the secretary, Dr. Arthur C. Hardy, at the Massachusetts Institute of Technology, Cambridge 39, Mass.

Dr. William F. Meggers, chief of the spectroscopy section of the Bureau of Standards, was elected president of the American Optical Society at a recent meeting. Dr. Meggers is noted for his many papers in spectroscopy and atomic physics, and for his extensive contributions to the establishment of standard wave lengths, the classification of spectral lines, and spectrochemical analyses.

THE DEUTERIUM REACTION

A process first discussed 15 years ago, now believed basic to the so-called hydrogen bomb, is the reaction between the nuclei of heavy hydrogen, the atoms of mass 2, called deuterium. Either hydrogen of atomic weight 3 is produced, or helium. This was explained recently to Science Service by Dr. Hans Bethe, of Cornell University, the originator of the carbon cycle theory which accounts for the energy radiated by the sun. For the process known as the D-D reaction to occur, temperatures are required which are comparable to those in stellar interiors, but they are less than for any other nuclear reaction between charged particles. Theoretically,

the only way to reach such temperatures, according to Dr. Bethe, is to use the fission bomb as a starter; but even so it is not known whether or not the D-D reaction can be started this way. This reaction is not the same as the carbon cycle in the sun, although both depend on the conversion of a small amount of mass into energy, according to Einstein's theory of the equivalence of mass and energy.

HEAVIEST ATOM

Berkelium is the name of a new element, number 97, created in the University of California 60- and 184-inch cyclotrons at Berkeley. Details about the new element are not yet available, although scientists have been predicting for some years that it would be found. Presumably it is very short-lived and very active; and its mass is probably as high as 247 or 248. The symbol for the new element will be *Bk*, since Be already stands for beryllium.

Nine chemical elements have been found within the past dozen years: elements 93 through 97 and the previous "gaps," 43, 61, 85, and 87. The periodic table is now complete through element 97. The discoverers of the latest element, according to Science Service, are Drs. Glenn T. Seaborg, Stanley G. Thompson, and Albert Ghiorso.

BRUCE MEDALIST

The directors of the Astronomical Society of the Pacific announced recently that they have chosen Dr. Alfred H. Joy, of the Mount Wilson Observatory (officially retired), as the Catherine Wolfe Bruce medalist for 1950. Dr. Joy is well known for his work on stellar spectra. He is both president of the American Astronomical Society and chairman of the astronomical section of the American Association for the Advancement of Science. Dr. Joy's picture appears on page 115, together with other officers of the American Astronomical Society.

BINDERS

for SKY AND TELESCOPE

File each issue as it comes . . . a new type of binder holds a year's issues . . . opens flat for quick use of your magazines . . . dark blue fabrikoid with SKY AND TELESCOPE gold-stamped on cover and back . . . reuse from year to year or keep each volume permanently bound in this form . . . **$2.95** **postpaid ($3.50 in Canada)**

Orders accepted for delivery in the United States and Canada only. Payment must accompany your order.

If you wish, your name gold-stamped, 50 cents extra; volume number, 30 cents; both, 75 cents. Please print the desired lettering clearly.

SKY PUBLISHING CORPORATION
Cambridge 38, Mass.

STARS AS MAGNETS

(Continued from page 108)

its axis of rotation lying along or near the line of sight is very much smaller than that of finding one with its axis inclined nearly at 90 degrees, and we must conclude that there are altogether too many narrow-lined peculiar *A* stars by comparison with the more usual *A* stars of normal spectrum (such as Sirius). Thus, the stars with large magnetic fields are probably rotating less rapidly than such well-known broad-lined stars as Altair, whose period of rotation is about six hours.

It also looks as though we should accept as real the large angles — up to 90 degrees — between rotational and magnetic axes, with the following possible conditions. When the angle is large and the axis of rotation is perpendicular (or nearly so) to the line of sight we observe a spectrum variable. When the magnetic axis and the rotational axis both roughly coincide with the line of sight, we observe a star with constant magnetic field and permanent spectroscopic peculiarity (Beta Coronae Borealis). And when both axes are roughly perpendicular to the line of sight, then Babcock's present polarization equipment will not suffice; the lines of force over most of the star's visible disk are perpendicular to the line of sight, and the quarter-wave plate is not needed.

In presenting these ideas I have combined my own views with those held by several other persons, notably Horace W. Babcock and Deutsch. The latter in recent years has done more than anyone else to study the spectrum variables. But I must mention that an entirely different explanation has been proposed by M. Schwarzschild. Following the line of thought indicated above in the case of a reversal of polarity in an electromagnet with alternating current in the coil, he attempts to show that if the star does not rotate around an axis which differs from the magnetic axis, then large-scale magnetohydrodynamic oscillations are needed to obtain the observed results.

It is premature to try to decide between these two equally remarkable hypotheses. But on the former we should perhaps think of a phenomenon like a pair of large, diametrically opposite "star spots," permanent in location and exhibiting magnetic fields similar to that of a normal, large sunspot, but having opposite polarities. If these spots are on or near the star's equator we have a spectrum variable. The advantage of this point of view is that it would relate the phenomenon of stellar magnetism to the established phenomenon of sunspots, and would not attempt to relate it to the rather shaky foundation of our knowledge of the sun's general magnetic field.

If the magnetic field of a star is large enough, the Zeeman splitting of the absorption lines may become visible even without the use of the polarizing analyzer in front of the spectrograph. Perhaps this splitting will explain some strange duplicities observed in the absorption lines of the spectrum variable, Epsilon Ursae Majoris.

THE ASTRONOMER

Through the long hours of the silent night
He presses on, a wanderer in space,
Seeking amid the myriad worlds to trace
Order from chaos. His the chosen right
To ferret reasons for the sudden blight
That causes novae: unafraid to face
The sphinx of Cepheids, or forspent to pace
With mathematic skill the comet's flight.

Buoyant, on wings of light the vasty deep
He penetrates. New worlds swim into ken.
Breathless with awe he gazes on the sweep
And swirl of mighty nebulae — and then
Perceives he's taken but a single leap
Toward the Infinite . . . . . And to that, when?

LABAN LACY RICE

A SPITZ PLANETARIUM

has been sold to UNESCO, for use in a scientific exhibition that will tour Latin America.

SCIENCE ASSOCIATES
401 N. Broad St. Phila. 8, Pa.

A SET OF NEW
Astronomy Charts

will be ready early in March.

THE TITLES ARE:

The Earthquake Speaks * Subterranean Astronomy * 16 Miles of Atmosphere * Into the Great Unknown Overhead * Atomic Microseisms * Storms — Hurricanes — Microseisms * Reading the Microseism's Story * Radar for Astronomy * Eclipses from Sunrise to Sunset * Seven Eclipses in One Year * Eclipse Noon-points — Polar Behavior * Eclipse Saros Sequence * Ephemeris Eclipse Plot * Ecliptic Limits * Umbral Solar Eclipses: 1948-1956 * 1957-1965 * 1966-1974 * 1975-1983 * 1984-1992 * 1993-2001 * Into the Shadow and Out * Our Moon in 1950 * Lunar Mid-eclipse Points: 1948-1965 * 1966-1992 * 1993-2001 *

The set of 25 charts above, 8½ x 11, punched for looseleaf notebook $3.00
First set still available at same price.

Any of the 50 charts, 27" x 35", each .. $3.00

24 35-mm. SLIDES in sturdy glass mounts, chart slides and Mt. Wilson pictures, ... $8.50

Save by a combined order:

Both chart sets (8½ x 11) ..... $ 5.75
Either chart set and slide set $11.00
Two chart sets and slide set $13.75

First chart set and slides mailed immediately — second set as soon as ready. New circular soon — want one?

ASTRONOMY CHARTED
4 Mason Street, Worcester 2, Mass., U.S.A.

BOOKS AND THE SKY

ART AND SCIENTIFIC THOUGHT

Historical Studies towards a Modern Revision of their Antagonism.

Martin Johnson. Columbia University Press, New York, 1949. 200 pages. $3.00.

THE AVERAGE practical scientist probably does not have sufficient breadth of interest to want to read this book. However, those basic scientists — and particularly astronomers — interested in the broad cultural effects of science on society, and somewhat removed from the merely utilitarian aspects of the subject, will find Dr. Johnson's unconventional thesis appealing and well worked out.

Extending his idea of "communication," which he uses in the very broadest sense of the word, from the application to relativity theory in his earlier work, **Time, Knowledge and the Nebulae,** the author points out a fundamental similarity between art and scientific thought (a similarity noted by Cassius Longinus about 250 A.D., I am told): The aim of both is essentially the **communication** of the pattern, form, or structure of mental images. In his words, "The test of validity of the scientist's 'pattern' of ideas is that its form must render it communicable." This criterion for distinguishing science from quackery Johnson proposes to apply to criticism of imaginative art, as distinct from representational art. His treatment brings up numerous interesting analogies between fantasy in art and the complex concepts of modern physics, both of which he maintains are equally far removed from direct sense experience.

In the second part of the book, Dr. Johnson shows how these notions apply to Beethoven's later music, to Chinese carvings in jade, to Gothic sculpture, to Russian ballet, and to the poetry of Walter de la Mare. In each case, these recognized examples of good art convey meaning through symbolism and imagery which, though remote from sense experience, can scarcely be said to lack reality. In the minds of an appreciative audience, he shows, these forms of imaginative art conjure up a state of mind, an atmosphere or a feeling in much the same way as the mathematical equations of wave mechanics or relativity convey meaning to mathematically-trained scientists.

But this similarity does not blind Dr. Johnson to the contrast between the arts and sciences; the former requiring the communicatee to "translate the original vision into something peculiarly of his own creation"; the latter laboring to make its communications intelligible to all possible individuals, under all varieties of circumstance.

The third part of the book is devoted to a historical study of the apparent gulf which has formed, relatively recently, between the arts and the sciences. Dr. Johnson wisely chooses the ancient Oriental cultures for this study, rather than the classical era in the Western world, on which numerous pronouncements have already been made to prejudice the issue. In this part, too, his second thesis emerges: the importance of Eastern culture has been too long neglected by the Western world. In this section there are very readable summaries of the development of Arabic astronomy, and of Chinese astronomy, both of considerable interest to scholars of the science untutored in such ancient history. Johnson's conclusion from these histories seems to be that a mixture of art and science is in some way "inflammable." The lack of separation of the arts from science in early times, he feels, reduced the quality of scientific output, and actually retarded the development of science through the strong conservatism — aesthetic attachment to outworn scientific concepts like the Ptolemaic system — which followed, for instance, the apex of Oriental science. Some readers may feel, as I do, that this point is scarcely proven, and that conservatism may develop whether or not the arts and sciences are separated.

Finally, Johnson discusses Leonardo da Vinci as one of the latest art-scientists. He takes the point of view that Leonardo worked in unbearable isolation under the tensions of a conflict within himself between his regard for natural law, as a scientist, and, as an artist, his concern for his fellow men who in his time were unscientific or even anti-science.

A more complete statement of his conclusions should be left to the author. In my opinion the great contribution of Dr. Johnson's book is not necessarily in his

Making Your Own Telescope **The Nature of Cosmic Rays**
Atlas of the Heavens **Sky and Telescope**

Sky Publications

Mappa Coelestis Nova **Splendors of the Sky**
Relativity and Its Astronomical Implications **Moon Sets**

MAKING YOUR OWN TELESCOPE, by Allyn J. Thompson, tells the complete story of how to make and mount a 6-inch reflecting telescope, at very low total cost. Excellent for use by telescope making groups. 211 pages, 104 illustrations. **$3.50**; foreign postage 40 cents

THE NATURE OF COSMIC RAYS, by W. F. G. Swann, gives a review of the fundamental physical and atomic principles involved in the study of this most powerful of all cosmic energies. 32 pages. **50 cents**

ATLAS OF THE HEAVENS, by Antonin Becvar and associates at the Skalnate Pleso Observatory. Sixteen charts cover the entire sky to magnitude 7.75, including doubles, multiples, variables, novae; galactic star clusters, globulars, and planetaries; 1950 co-ordinates. Each chart area is 15½ by 23½ inches. **$5.00**

SKY AND TELESCOPE may be sent as a gift; if requested, a donor's card is sent to the recipient of each gift subscription.

MAPPA COELESTIS NOVA, by Josef Klepesta, is a large wall chart, colorful as well as informative. The northern sky to —45° is shown on a polar projection, and each star is colored according to its spectral class. The chart makes a fine transparency, 28 inches square. **$3.50**

SPLENDORS OF THE SKY is a bargain in astronomical photographs, with explanatory captions, now in its third printing for a total of 36,000 copies in eight years. 36 pages, each 8½ x 11½ inches. **35 cents**, plus 5 cents postage

RELATIVITY AND ITS ASTRONOMICAL IMPLICATIONS, by Philipp Frank, is an outstanding explanation of the general theory of relativity, in language suitable for the layman. 24 pages. **50 cents**

MOON SETS are 18 full-sized plates, nine for the first-quarter moon and nine for the last quarter, from Lick Observatory negatives. Each plate is on a sheet of heavy stock 12 by 18 inches, and there are key charts for named lunar features. **$2.00**

All prices are postpaid except as otherwise noted. Order from your favorite bookstore, from the Adler, Buhl, Fels, Hayden, or Morehead Planetarium (see Planetarium Notes for addresses), or write us directly. Payment should accompany all mail orders.

SKY PUBLISHING CORPORATION
HARVARD COLLEGE OBSERVATORY, CAMBRIDGE 38, MASS.

conclusions, but in the all-important problem he raises — the problem of how science should fit into our culture — and in his scholarly and scientific approach to this problem. Among the younger scientists of today who have examined the structure of scientific knowledge, there should be little disagreement over the similarities between creative efforts in art and in science. Such readers I would expect to go even further than Johnson; they would deny that art and science are incompatible, and would scoff at the dangers he sees in educating scientists in the meaning of the arts, or artists in the meaning of science. Although Johnson's point is well taken, that many prominent scientists have written poor philosophy and few philosophers have fully comprehended modern science, still, the same defects are certainly to be noted within any one discipline. (How many astronomers are able to comprehend both accurate spectral classification and theoretical quantum dynamics?) It would seem appropriate in any true seat of learning to continue efforts to bridge the gulf between the arts and the sciences by requiring a certain breadth of education in all fields of human knowledge — in the university tradition of long standing — before a student specializes in any one field, be it art or science. Otherwise, we shall achieve such sterile heights of specialization that some scientist-philosopher of the future may write of the gulf between theoretical and practical astronomy, say, in the same way as Dr. Johnson treats of art and scientific thought.

THORNTON PAGE
University of Chicago

OSCILLATIONS OF THE EARTH'S ATMOSPHERE

M. V. Wilkes. Cambridge University Press, New York, 1949. 74 pages. $2.50.

WHILE it had been surmised in the 18th century that the same lunar and solar gravitational forces that produce the tides in the ocean should also have their effect on the atmosphere of the earth, it was soon found that the latter effect (deduced from barometric measurements) appeared to depend on the sun alone. Laplace got out of the quandary by suggesting that the atmospheric tides depended largely on the thermal action of the sun.

Then Kelvin, in 1882, showed Fourier components with periods of 24, 12, and eight hours, and pointed out that the 12-hour component was larger than the 24-hour, contrary to what the thermal theory would predict. He suggested that the atmosphere has a free period of about 12 (rather than 24) hours. This proposal of Kelvin is the origin of the "resonance theory" with which Wilkes' treatise is largely concerned.

The atmosphere of the earth is a complicated structure in which solar and lunar tides, peculiar temperature and density gradients, and the ionized E, F, and other layers are some of the prominent factors to be considered and accounted for. At high altitudes even the best modern data are rather incomplete. This book attempts to give a physical theory of air tides to account for the observed facts.

Replete with mathematical formulations, technical diagrams, and scientific references, **Oscillations of the Earth's Atmosphere,** one of the Cambridge monograms on physics, is not a book for the lay reader, with the exception of the first half-dozen pages of historical introduction.

DORRIT HOFFLEIT
Harvard College Observatory

THE HISTORY OF THE CAMBRIDGE OBSERVATORIES

F. J. M. Stratton. Cambridge University Press, New York, 1949. 26 pages and 8 plates. $1.25.

IT HAS BECOME traditional that a new observatory inaugurate its publications with an historical outline of its founding, and a description of the buildings and telescopes. In the excitement of installing new instruments, exploring the heavens therewith, and instituting new researches, the directors of some notable observatories have been understandably tardy about completing these mementos.

Surely pre-eminent in this regard is the current publication, Volume I of the **Annals** of the Solar Physics Observatory, Cambridge, England. This first volume has been preceded by several volumes of the Solar Physics **Annals** and a whole shelfful of publications of the Cambridge University Observatory.

The occasion of the publication of the missing first volume was the final unification in 1946 of these two historic observatories. Professor Stratton has enthusiastically played a prominent role in the life of the Solar Physics Observatory, of the International Astronomical Union, and of Cambridge University.

This small book systematically sketches the more important points of the histories of the two observatories and the university. It must have been very hard to select and condense the available material to such an extent. Perhaps some day in some less formal place Professor Stratton will recount anecdotes of these great institutions.

FRANK S. HOGG
David Dunlap Observatory

MICROFILM SERVICE

Beginning with Vol. IX, **Sky and Telescope** will be available to subscribing libraries and others in microfilm form, through an arrangement with University Microfilms, of Ann Arbor. By this means, in lieu of or in addition to bound volumes, and after the current use of the paper copies has passed, the microfilm edition, with the entire volume reproduced on a single roll, may be substituted. This modern method of preserving back issues of periodicals is helping to solve the pressing storage problem of most libraries. Sales of the microfilm are restricted to those subscribing to the paper edition, and the film copy is distributed at the end of the volume year. Inquiries concerning this service should be made direct to University Microfilms, 313 N. First St., Ann Arbor, Mich.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 15, Mass. Richmond 2-1410.

SCHEDULE: Tuesday thru Friday at 4 p.m.; Saturday, 11 a.m., 3 and 4 p.m.; Sunday, 3 and 4 p.m. Spitz projector. In charge, Charles A. Federer, Jr.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings as 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

13-INCH SETTING CIRCLES

OBSERVERS — EQUIP YOUR MOUNTINGS WITH CO-ORDINATE CIRCLES

$35.00 a pair

With these large, finely made circles carrying 1440 divisions each, you can instantly find stars and nebulae that are invisible to the naked eye and also identify them from the catalog.

1. Set declination of star first. 2. Set the time circle (upper graduations) to the right ascension of the star with the telescope stationary. 3. Now move the telescope carrying the time circle until the lower graduations read your local sidereal time. The star will be centered in your low-power eyepiece. Free instructions and sidereal-time formula.

To identify a star: While it is in the telescope, move the time circle to sidereal time and take readings of the R. A. and Dec. Then compare with the star catalog.

ELECTRIC SIDEREAL CLOCK

Sidereal time is required for the positive location and identification of celestial bodies visible or invisible to the naked eye.

This clock has gears that give a computed rating of less than six minutes slow in a century. Cast aluminum base, bronze front bezel, 4″ minute circle, metal dial. Hands may be set from the front or back. 110 volts 60-cycle or 50-cycle on request. Good for all climates. **$36.00.**

Observers wishing to convert their standard clocks to sidereal may do so under our free instruction. The cost of gear changes is about $5.00. 24-hour dials may be had directly from John Stofan, 332 Herrick Ave., Teaneck, N. J., at a cost of $1.00 each.

Haines Scientific Instruments

Box 171, Englewood, New Jersey

Telephone: ENglewood 3-3441-J

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A TELESCOPE DESIGNED FOR SOLAR SYSTEM OBSERVATIONS

FROM GERMANY we have received copies of an article by H. F. A. Tschunko describing a type of telescope and mounting which amateur telescope makers will recognize as similar to the well-known Springfield mounting developed in this country. Mr. Tschunko's article appeared in the **Publications** of the Badisch State Observatory, Heidelberg, Vol. 15, No. 10, and is dated April 5, 1949.

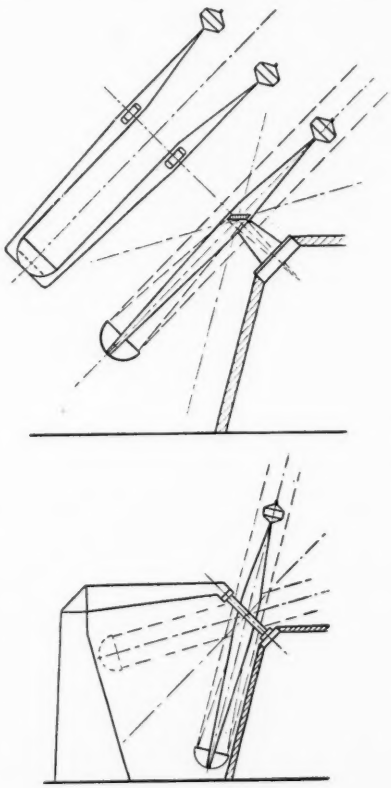
A translation has been furnished us by Fred Gutmann, and portions of this translation (abbreviated in some places) are quoted in the following discussion of the Tschunko reflector. The illustrations are taken from the publication mentioned above, and this department has on hand about 25 reprints of that article (in German) that will be supplied on request to interested amateurs, as long as the supply lasts.

Mr. Tschunko begins by pointing out that there are many types of telescope design to facilitate comfortable operation, usually having fixed or almost fixed eyepieces, and often permitting closed observation chambers. The Springfield mounting is one of these, but it does not fill all the conditions which Mr. Tschunko sets forth as necessary to attain maximum image quality, maximum amount of illumination, and best definition:

"1. The number of reflections and refractions in the optical path should be kept at a minimum. 2. Reflecting and refracting auxiliary surfaces should have minimum area. 3. These surfaces should be as close as possible to the focal plane to minimize inaccuracies. 4. The number of reflections should be even, to avoid inversions. 5. The eyepiece axis should be at about right angles to the observer's body. 6. The zone of observation should include the equator and the ecliptic and at least 60 degrees in declination to permit viewing of the solar system. 7. The view into the instrument must be fixed in space and direction; stationary eyepiece and focal plane are required. 8. The observation chamber should be separated from that containing the instrument, and should be sealed, if possible. 9. Eyepieces should not contain lens systems that produce chromatic aberration, and should give images of maximum contrast. Note that aberrations of the parabolic mirror off axis are of minor importance in physics research, while for visual observation image quality at and near the optical axis is paramount. 10. The reflection angle of the directional mirror should be an advantageous one when the instrument is operated at extreme declination. 11. The optical system should facilitate construction of the instrument. 12. Free circulation of air should be possible in the space ahead of the objective mirror."

Note that condition No. 6 is much more restrictive than would satisfy amateurs and most professionals in this country. Although Mr. Tschunko shows several designs reaching 45 degrees north and south of the celestial equator, the unavailability of the polar regions will make his design intolerable to those with only one telescope available for all purposes. Nevertheless, modifications of his design may be developed by a reader of this department, in which event we would be pleased to receive a description of such possible improvements. The Springfield mounting, of course, permits observation of the entire sky.

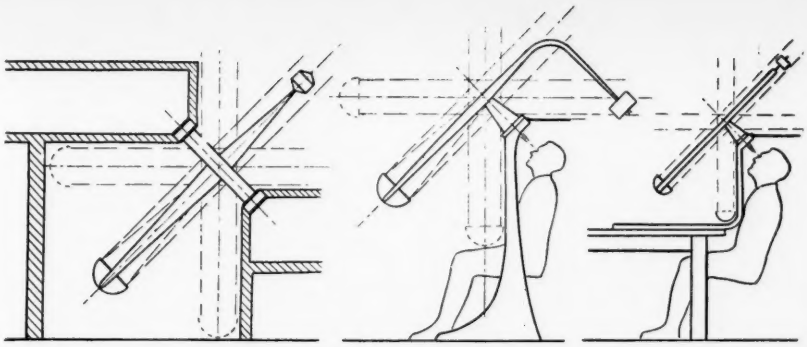
"Adherence to the above design conditions excludes consideration of large plane mirrors placed ahead of the objective, including stationary telescopes with



A, above: The Tschunko telescope with one bearing and a fork mounting. B, below: With a yoke mounting and a cantilever upper support.

driven plane mirror ahead of the fixed instrument tube. Instruments incorporating more than one auxiliary mirror or more than a total of two reflections also fail to meet the above conditions. Thus, the optical system should include one imaging and one directional reflection; the former is the mirror objective, and the latter an auxiliary directional mirror located near a fixed focal plane. This second mirror must be located at the intersection of hour and declination axes, and must be deflected at one half the declination."

Factors entering into the design are the focal ratio; the length of the deflected cone of light; the required image area and



C, left: A large instrument with a second observing room. D, center, and E, right: Two adaptations for a fork-type mounting. E is a 4-inch, f/5 instrument.

the diameter of the axial projection of the secondary mirror; the maximum travel in declination desired or permitted by the mounting; the distance between the declination axis and the main bearing; and the observatory's latitude.

As may be seen from the diagrams, the focal ratio determines the structure of the mounting, and a focal ratio of f/5 can easily be procured. The secondary mirror must be mounted and controlled to rotate around the declination axis. Mr. Tschunko has developed what he calls a "fork truss" in place of the tube, thus achieving his condition No. 12. This fork truss carries counterweights at its upper ends, and it is supported by a yoke type of mounting, where two "piers" are provided, or by another fork turning in the polar axis in the conventional manner.

He points out that the reflection angle on the auxiliary mirror is more advantageous the smaller the zenith distance becomes, and that the most numerous observations are located at higher declinations — the instrument is most efficient in the area of maximum usage (except for locations north of the zenith, where it cannot be used at all). He suggests that in small instruments the secondary can be operated by means of a parallelogram linkage, the backlash being taken up by a compression spring acting upon the diagonal member.

Several styles of mounting are illustrated in the original article. **A** is a one-bearing mounting, with a range in declination of 60 degrees, to cover half of the sky. At f/6 aberrations are at a minimum, with an image area sufficient for photographic observations. It is this type that Mr. Tschunko also shows as it might operate inside a conventional dome for a refractor, with a portion of the usual observing area closed in to form the observer's chamber. **B** shows a cantilever support for the upper polar axis, but he mentions that this design has no particular advantages. **C** is for a large instrument, where a second observation room is provided in the upper support, similar to the equatorial coude. The range of this and mountings **D** and **E** is 90 degrees in declination. **D** is an 8-inch reflector placed on a pedestal-type fork mounting. The tube body and the lever arms which carry only one counterweight are replaced by a modified fork truss, a triangular frame. This does not show in the drawing, but its form may be inferred by refer-

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

EVERYTHING FOR THE AMATEUR

TELESCOPE MAKER

KITS 6"—$5.50 up; Pyrex, 6" ... $7.50 up. Other sizes in proportion.

ALUMINIZING

Superior Reflecting Surface, Fine Finish. Will not Peel or Blister. Low Prices.

Mirrors Tested Free | Prisms Eyepieces Accessories | Send for Free Catalog

MONEY BACK GUARANTEE

Precision Optical Supply Co.

1001 E. 163rd St., New York 59, N. Y.

Complete Telescopes

Reflectors and Refractors suitable for universities and private use. All optical parts of the highest quality.

Ramsden Eyepieces

that have satisfied hundreds of buyers.

Equivalent focal lengths ¼", 1/3", ½", ⅔", 1" ..... $5.15 each
1¼", 1½", 2" ..... 10.25 each
All standard 1¼" diameter; postpaid

FINDERS that can be swung to either side of tube for convenience.

Send for free price list and description on complete Telescopes, Mountings, Combination Eyepiece and Prism Holders, Aluminum Mirror Cells, Star Diagonals, Prisms.

C. C. Young

25 Richard Road East Hartford 8, Conn.

A 16" mirror and subdiameter tools.

LARGE-DIAMETER MIRRORS

MADE TO YOUR ORDER.

MIRRORS UP TO 36" AVAILABLE.

For further information, inquire

J. O. PAULSON, R. R. 3, Navarre, Ohio

WAR SURPLUS BARGAINS

$1200.00 VALUE FOR $95.00

SCISSORS TELESCOPE — Gives 100 times greater stereoscopic power than the unaided eye. Binocular type. Big field of view. 12 power. Furnished complete with tripod, mount and case. Used by Army and Navy for long distance spotting, target observation, etc. Used but good condition. Shipped f.o.b. Camden, N. J. (Weight approx. 79 lbs.).
Stock #952-Y $95.00

CONDENSING LENSES — Seconds, but suitable for Enlargers and Spotlights.
Stock #1103-Y–29/32" dia. ½" F.L. $ .50 ea. p.p.
Stock #1086-Y–1-11/16" dia. 3" F.L. $ .25 ea. p.p.
Stock #1077-Y–2⅜" dia. 3" F.L. .. $1.00 ea. p.p.
Stock #1084-Y–2½" dia. 4" F.L. ... $1.00 ea. p.p.
Stock #1099-Y–4-7/16" dia. 6½" F.L. $1.20 ea. p.p.
Stock #1080-Y–5" dia. 7" F.L. .... $1.00 ea. p.p.
Stock #1019-Y–6" dia. 16" F.L. .... $2.00 ea. p.p.
Stock #1061-Y–6½" dia. 9" F.L. ... $2.50 ea. p.p.

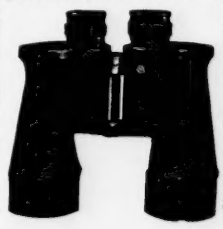
MOUNTED TELESCOPE EYEPIECE — Kellner type. Excellent astronomical and other telescopes. War Surplus. Government cost about $18.00. Focal length 24 mm. Lens diameter 23 mm. Unusually wide field.
Stock #5189-Y ..... $3.25 Postpaid

ADAPTER MOUNT (not surplus)—2⅛" long with standard 1¼" O.D. for use on astronomical telescopes. Threaded so Stock #5189-Y screws into it. Black anodized.
Stock #5190-Y ..... $1.00 Postpaid

CROSSLINE RETICLE — Dia. 29 mm.
Stock #2036-Y ..... 50c Postpaid

Government's 7 X 50 Binoculars

Assemble Them Yourself! Complete Optics! Complete Metal Parts! Save More Than ½ Regular Cost!



METAL PARTS—Set includes all metal parts—completely finished — for assembly of 7 X 50 Binoculars. No machining required. Sturdy Binocular Carrying Case is optional with each set of Metal Parts.
Stock #842-Y. $39.40 Postpaid, plus $4.80 for Case. Total $44.20

OPTICS—Set includes all Lenses and Prisms needed for assembling 7 X 50 Binoculars. These are in excellent condition — perfect or near-perfect — and have new low reflection coating.
Stock #5102-Y ..... $25.00 Postpaid

Note: These are fine quality standard American-made parts, not Japanese.

NOTICE! If you buy both Binocular Optics and Binocular Metal Parts, add 20% Federal Tax.

ARMY'S 6 X 30 BINOCULARS

COMPLETE OPTICS & METAL PARTS—Model M-13A1, 6 x 30 Binoculars (Waterproof Model). Everything you need—ready for assembly. When finished will look like regular factory job costing $102 to $120. Optics are new, in perfect or near-perfect condition. Have new low reflection coating. Metal Parts new and perfect, all completely finished. Complete assembly instructions included.
Stock #830-Y ..... $40.00 Postpaid
plus $8.00 tax—Total—$48.00

NEW BULLETIN on our BIG VARIETY OF PRISMS—Request Bulletin Y.

FIRST-SURFACE MIRRORS
Stock #539-Y—60 mm. x 80 mm. .. 75c Postpaid
Stock #558-Y—45 mm. x 74 mm. .. 50c Postpaid
Stock #547-Y—43 mm. x 140 mm. .. 50c Postpaid
Stock #534-Y—25 mm. x 29 mm. .. 25c Postpaid

TELESCOPE EYEPIECE—Consists of 2 Achromatic Lenses, F. L. 28 mm. in a metal mount.
Stock #5140-Y ..... $4.50 Postpaid

SIMPLE LENS KITS!—THE LENS CRAFTERS DELIGHT! Fun for adults! Fun for children! Kits include plainly written illustrated booklet showing how you can build lots of optical items. Use these lenses in photography for copying, ULTRA CLOSE-UP SHOTS, Microphotography, for "Dummy Camera," Kodachrome Viewer, Detachable Reflex View Finder for 35-mm. cameras, Stereoscopic Viewer, ground glass and enlarging focusing aids. And for dozens of other uses in experimental optics, building TELESCOPES, low power Microscopes, etc.
Stock #2-Y—10 lenses ..... $1.00 Postpaid
Stock #5-Y—45 lenses ..... $5.00 Postpaid
Stock #10-Y—80 lenses ..... $10.00 Postpaid

SLIDE PROJECTOR SETS—Consist of all unmounted lenses you need to make the following size projectors:
Stock #4038-Y — 2¼" x 2¼" ..... $3.35 Postpaid
Stock #4039-Y — 2½" x 3½" ..... $3.35 Postpaid
Stock #4035-Y — 35 mm. ..... $4.85 Postpaid

We Have Literally Millions of WAR SURPLUS LENSES AND PRISMS FOR SALE AT BARGAIN PRICES. Write for Catalog "Y"—FREE!

Order by Stock No. *Satisfaction Guaranteed*

EDMUND SALVAGE CO.

BARRINGTON, NEW JERSEY

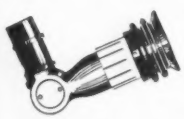
WAR SURPLUS BARGAIN

OPTICS

ACHROMATIC TELESCOPE OBJECTIVES — Perfect Magnesium Fluoride Coated and cemented Gov't. Surplus lenses made of finest Crown and Flint optical glass. They are fully corrected and have tremendous resolving power. Guaranteed well suited for Astronomical Telescopes, Spotting Scopes, etc. Gov't. cost approximately $100.00.

Diameter	Focal Length	Each
54 mm (2⅛")	600 mm (23½")...	$12.50
76 mm (3")	381 mm (15").....	19.00
81 mm (3 3/16")	622 mm (24½")...	22.50
88 mm (3¼")	876 mm (34½")...	28.00
83 mm (3¼")	1016 mm (40")	30.00

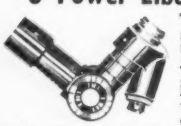
LENS CLEANING TISSUE—Here is a wonderful Gov't. Surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications. 500 sheets size 7½" x 11". **$1.00**



3x ELBOW TELESCOPE — Makes a nice low priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, light weight, 2 lbs. Gov't. Cost $200.

Plain Optics **$6.50** Coated Optics **$10.50**

8 Power Elbow Telescope



Tremendous Wide Angle Eyepiece, apparent field of view 70°. Objective 1⅛" Diameter. Amici Erecting System. Brass construction, weight 28 oz. Small, compact, 1¾" x 4¾" x 4½". Has graduated crossline reticle with lamp housing to illuminate reticle. The Telescope contains a short focal length eyepiece, E.F.L. .602", which has 5 lenses.

ARMY USED **$18.50**

BRAND NEW **$27.50**

Specials ! !

Rectangular Magnifying Lens—Seconds, sells for $6.50. Size 2" x 4"	$1.00
Optical Peep Sight—Use as Camera viewfinder, etc. Dia. 1½", weight 1½ oz. ..	1.50
Hobbyist Set—Fun for Young and Old. 10 assorted lenses and booklet	1.00
Magnifying Lens, 2" Dia., Coated ....ea.	1.00
Magnifying Lens, 3" Dia., Coated ....ea.	2.00
7x50 Binocular Objective, Coated ....ea.	3.75
7x50 Binocular Prism, Coated .....ea.	2.00
6x30 Binocular Objective, Coated .....ea.	1.75
6x30 Binocular Prism, Coated .....ea.	1.50
Kellner Eyepiece Lens Set, 22 mm F.L. .	2.50
Right Angle Prism, ⅞" Face	1.25
Right Angle Prism, 1½" Face	2.00
Right Angle Prism, 1⅞" Face	3.00
Right Angle Prism, ⅝" Face	.75
Porro-Abbe Prism, ⅝" Face	.50
Dove Prism, ½" Face	.75
Dove Prism, ¾" Face	1.50
Amici Roof Prism, 11/16" Face, Coated ..	2.50
Amici Roof Prism, 13/16" Face, Coated ..	2.75
Lens Cement, Stick Canada Balsam	1.00
8-mm Projector Condensing Lenses ..Pr.	.60
First Surface Mirror, 12" x 15"	8.75
First Surface Mirror, 8" x 10"	4.25
First Surface Mirror, 4" x 4"	1.25
First Surface Mirror, 1¼" x 1½"	.25
Penta Prism, 18 mm Face	1.65
Rhomboid Prism, 18 mm x 25 mm Face, 50 mm Long	3.00
Porro-Abbe Prism, 27 mm Face, 55 mm Long	2.00
Amici Prism, 34 mm Face	6.50

HEAT ABSORBING PLATE GLASS

2" x 2"..10c 4" x 5"..35c 6" x 6"..50c

"FREE CATALOGUE"
Sensational Optical Bargains
Send for it TODAY

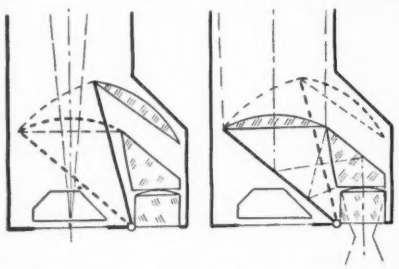
WE PAY THE POSTAGE

A. JAEGERS 93-08S 95 AVE. OZONE PARK 16, N. Y.

ence to the upper part of diagram **A**, where the "fork truss" is pictured as seen from the north or south sides. It is possible to modify the design of **D** to make room for the observer's seat. **E** is a small 4-inch instrument mounted on a table, and pipe is used to make the "fork truss." It is mentioned that Harvard Observatory coronagraphs are mounted along these lines, with modification to support a refractor tube.

The image is neither inverted nor reverted, and it moves opposite to the daily motion. It is suggested that the eyepiece end of the tube can be connected to the body of the fork truss, thus providing compensation for the rotation of the field.

A finder is needed, and for this purpose



The diagram used by Mr. Tschunko to illustrate the hinged type of eyepiece finder.

Mr. Tschunko proposes use of the main eyepiece, or of a part of its area. To permit rapid insertion of a viewfinder eyepiece a Huygens-type eyepiece of folded construction is made, employing a hinge-mounted mirror and a reflecting prism between field lens and eye lens. The reflecting prism, together with the plane-parallel plate, prevents movement of the exit pupil behind the main focal plane. It is pointed out that in construction embodying fixed or nearly fixed eyepieces and enclosed observing rooms the installation of a finder is in most cases omitted altogether because hardly ever can the eyepiece of the finder be made readily accessible near the main eyepiece.

A portion of the original article is devoted to the subject of binocular eyepieces, and to the arrangements whereby a drafting table can be positioned parallel to the eyepiece axis. The only optical element in the path of the light is a 45° coated reflector.

"An enclosed observation room with fixed focal point is advantageous for many types of physical investigations. It permits working at normal temperatures, prevents rapid changes in air temperature and humidity, does not permit air warmed by the body of the observer to enter the incident light path. The eye does not tire, and the secretion of tears caused by low temperatures is minimized. Furthermore, wind has no immediate effect, and observer and instrument are protected from rapid loss of heat. In some cases, protection from insects is important. The observation room can be connected with an office."

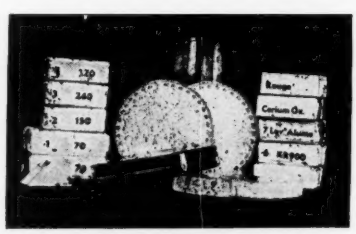
In his summary, Mr. Tschunko points out that with the exception of large-sized instruments with moving platforms, no other conventional type of telescope fulfills the requirements of maximum performance as well.

Coated Astronomical Objective
3⅛ inch by 50-inch focal length, air spaced, in black anodized duraluminum barrel.
• Individually hand corrected and figured •
Price $62.00
Dioptric Engineering Laboratories
47 West 56th St., New York 19, N. Y.

ALUMINIZING

HARD BER-AL COATING
Our exclusive high-reflectivity BER-AL coatings are free from chromium and they are not overcoated with fluorides or quartz. They can be removed easily, when desired, without harm to the glass surface below. Prices for BER-AL coatings, f.o.b. Chicago, are: $2.50 for 6" diameter mirrors, $3.50 for 8", $5.00 for 10", and $8.00 for 12½". Larger sizes up to 24" diameter on request.
LEROY M. E. CLAUSING
4544 N. Western Ave. Chicago 25, Ill.

New Low Prices on PYREX Reflecting Telescope Kits



Two circle dials with every Pyrex Kit.

The most complete kits on the market. In addition to the usual supply of abrasives, rouge, etc., you get the new, fast-polishing cerium oxide to save hours of work. You can get a brass diagonal holder (spider) for only $1.00 additional if ordered with a telescope kit. Prices quoted below are for a Genuine Pyrex telescope blank and a plate glass tool.

PYREX MIRROR KITS

4"	$ 5.25	6"	$ 6.75
8"	9.75	10"	16.75
12½"	31.75	16"	65.00

4" to 16" PYREX CARRIED IN STOCK

PLATE GLASS KITS

6" x ¼"	$4.75	6" x 1"	$ 5.25
8" x 1"	7.25	9¼" x 1½"	12.50

Postage Paid to 1st and 2nd postal zones from N. Y. Add 5% 3rd and 4th zones, 10% 5th and 6th zones. Add 15% 7th and 8th zones.
Parabolic pyrex mirrors made to order.
Send for free catalog of optical supplies.
DAVID WILLIAM WOLF
334 Montgomery St. Brooklyn 25, N. Y.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

FURTHER NOTES ON SATURN'S RINGS AND TITAN

OBSERVATIONS of Saturn during the fall months of 1949 have clearly revealed a shadow cast by the rings upon the ball of the planet, and one could detect that the shadow was north of the rings by carefully comparing its position to that of the ring appendages that appeared as straight lines east and west of the disk. There have been reports that when the rings became invisible in 1937, the shadow remained in view. It seemed natural to suspect that it also would disappear under certain conditions and then reappear on the southern side of the rings. The circumstances have been investigated and reveal some interesting facts that have a bearing on the transits, occultations, and eclipses of Saturn's moons.

The edges of the rings appear projected upon the celestial sphere as ellipses of varying eccentricity which degenerate into a straight line when their plane passes through the observer's position. In the **American Ephemeris and Nautical Almanac,** data are tabulated at eight-day intervals giving angular diameters of the major and minor axes of the outer edge of the rings and also the position angle of the minor axis. Imagine the major axis extended all the way around the sky to form a great circle passing through the center of the planet (Fig. 1). During a year such as 1950, when the plane of the rings passes through the sun, this circle makes an angle of 28 degrees with the ecliptic, that being the angle by which the ring plane is inclined to that of the earth's orbit.

At intervals of a little more than six months, the sun appears alternately at the two diametrically opposite points where this extended great circle through the major axis meets the projected great circle of the ecliptic on the celestial sphere. One occasion is near conjunction of Saturn with the sun; the other, near opposition. They would be at precisely the times of those configurations if the planet revolved in the plane of the earth's orbit. When the latitude and position angle are as in 1950, they take place a few days before conjunction and opposition. At such times, the Saturnicentric latitude of the earth and sun, plotted as B and B′ in Fig. 1 on page 95 of the February **Sky and Telescope,** are equal, to a high degree of approximation. This equality is exact when the planet is on the ecliptic.

At about 9^h Universal time on March 3, 1950, four days before opposition, the sun is at one of the intersections of the two great circles mentioned. The center of the earth's invisible shadow is at the other intersection, at the point R shown in Fig. 2, about four degrees from the apparent position of the planet. Imagine for a moment that the rings are exactly edgewise as in the diagram, their plane passing through both the earth and sun. Under such conditions the shadow of the rings would be in their plane and both would be invisible.

Should the sun, earth, and the planet lie in a straight line (the planet being at the point R also), a satellite revolving in the plane of the rings would similarly hide its shadow. However, under the conditions of Fig. 2a, the shadow of such a satellite would be projected upon the ball of the planet as shown, a little nearer the center of the earth's invisible shadow, i.e., away from the apparent position of the sun. In other words, the shadow of the satellite in transit would precede the satellite itself, both moving to the right or westward (on the sky), as is familiar to the reader when considering Jupiter's moons as they appear before opposition.

Suppose the planet were tipped about an axis lying in the ring plane and perpendicular to the line of sight. It would then appear as in Fig. 2b, and the moon and shadow would pass north of the center of the disk. If this tipping were very slight, as is the case in 1950 when it remains less than five degrees, the projections of the rings and satellite orbit upon the disk would remain essentially straight lines but displaced from the center by different amounts proportional to their actual distances from the planet.

Now comes the main distinction between the phenomena of Saturn's moons and those of Jupiter. The major satellites of both planets revolve essentially in the planes of their respective equators. However, Jupiter's equator is inclined by a very small amount to the plane of its orbit and to that of the ecliptic. As a result, three of its bright moons transit during every revolution, and the shadows they cast on the planet follow nearly the same projections upon the disk as do the satellites themselves. There is, of course, the lead of shadow before opposition and the lag after opposition already described, but there is relatively little separation of the projected paths in the direction perpendicular to the motion of the satellites. On the other hand, the 28-degree inclination of Saturn's equator to the ecliptic results in the shadow of a moon often appearing considerably north or south of the projection of the satellite itself.

The same is true with the shadow of the rings. In the fall of 1949 and the early winter of 1950, the sun was below the apparent major axis of the ring system and the shadow was north of the rings. Had the orbit of Titan appeared edgewise from the earth, that moon would have undergone central transit at each inferior conjunction while its shadow would have passed north of the center of the disk.

Actually the orbits of the rings and satel-

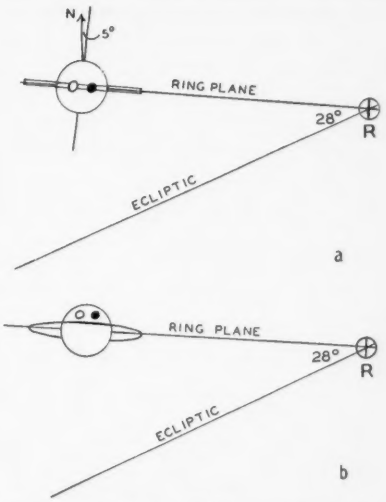


Fig. 2a (top). The satellite and its shadow both in transit in the ring plane. Fig. 2b (bottom). The satellite and its shadow transit in the same straight path parallel to the major axis of the rings but displaced to the north.

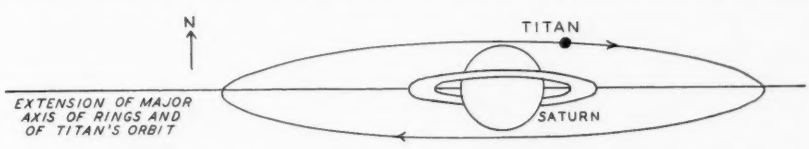


Fig. 1. The appearance of Saturn in the spring of 1950, with the tilt of the rings greatly exaggerated to show the principles described in this article. The extension of the major axis of the rings can be imagined as going around the sky.

For the first time an instrument capable of serious astronomical research is available for less than $200.00! The Saturn 3 Inch Portable Refractors are precision made by the West's largest makers of observatory instruments; objective lenses are highest grade precision ground, achromatic f-15 crown and flint glass, all moving parts are precision machined.

Although the Saturn 3 Inch Refractor has a 45 inch focal length, the instrument is easily portable, weighing less than thirty pounds, including tripod.

Saturn 4 Inch Portable Refractors from $345.00; larger instruments manufactured to order.

Write for literature giving full information on the Saturn Refractors.

Tinsley

2530 Grove Street
Berkeley, California

lite were still opened up a little so that the southern edges were visible. As a result, Titan was in transit north of the center and its shadow missed the disk completely. Similarly at superior conjunction it was occulted but passed south of the umbra of Saturn's shadow (Fig. 3a). Since December, its orbit has appeared to open up, as has that of the rings. By the 1st of March it clears the planetary disk at each revolution (Fig. 1).

After March 3rd, the shadows of the rings and satellite will be south of the projections of the objects themselves. Accordingly, Titan's shadow will transit the disk, while the satellite passes north of the limb at inferior conjunction. Similarly, the umbra of Saturn's shadow will be below the apparent major axis of the rings and satellite orbit so that at each superior conjunction Titan will undergo eclipse but not occultation (Fig. 3b).

Toward the end of the month of May, the rings and satellite orbit will appear to close again. At some time during the summer, transits and occultations of Titar will be resumed, the eclipses and shadow transits continuing to occur with each revolution. None of this new series will be observable from the United States, however, because they will take place during daylight hours.

An imaginary observer at the sun would see the orbits of Titan and Saturn's rings closing and reopening in 1950 at a virtually uniform rate. This is the significance of curve B′ in the graph that was printed in the February **Sky and Telescope.** For this observer, occultations, shadow transits, and physical transits would all begin at the time the orbit of Titan appeared tangent to the limb of Saturn. The first transit would be near the north pole, and successive ones would take place in more southerly latitudes until the last one occurred near the south pole. The terrestrial observer sees eclipses and shadow transits at the same time as the solar observer (except for the Doppler effect), but the circumstances of occultations and physical transits are different because of the inclination of the plane of the earth's orbit to that of the rings and satellite, and because of the varying elongation of the earth from the sun, as viewed at the planet, which may reach a maximum of six degrees.

PAUL W. STEVENS
Rochester Academy of Science

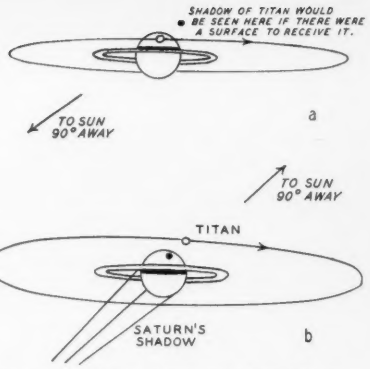

SHADOW OF TITAN WOULD BE SEEN HERE IF THERE WERE A SURFACE TO RECEIVE IT.
TO SUN 90° AWAY
a
TO SUN 90° AWAY
TITAN
SATURN'S SHADOW
b

Fig. 3a (top). The situation when Saturn was at quadrature in December, 1949, with the sun 90° away in the sky. The shadow of Saturn is not shown.

Fig. 3b (bottom). The June, 1950, situation, with Saturn at quadrature in the evening sky. Actually the rings appear as a straight line because they are so nearly edge on. The shadow was north of them in December; will be south of them in June.

DEEP-SKY WONDERS

SPRING SKIES bring many superb evenings to the watcher of galaxies and star clusters. The best nights are often those which occur after a cold front of maritime air has passed over in the late afternoon. The atmosphere is then not too cold and the smoothness of the ocean-born air mass makes for exquisite seeing. Such nights occur in the spring, and if your paper carries the daily weather map, it will be profitable to learn how to decipher its isobars and frontal symbols.

These fine spring evenings are especially good for the scattered clusters in the Gemini-Cancer region. Whether you use opera glasses, a rich-field reflector, or a more traditional instrument, you are assured of a veritable excess of stellar diamond dust. No description yet printed has done justice to the rewards to be found by lazy sweeps through this treasure lode of the heavens.

WALTER SCOTT HOUSTON

BRIGHT ASTEROID POSITIONS

Ephemerides for bright asteroids which are well placed for observation at about this time appeared in the February issue, page 98.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

VARIABLE STAR MAXIMA

March 1, RV Centauri, 7.6, 133**155**; 3, R Pegasi, 7.9, 230110; 5, R Andromedae, 7.0, 001838; 12, T Ursae Majoris, 7.9, 123160; 14, S Ursae Majoris, 7.9, 123961; 15, R Normae, 7.2, 152**849**; 16, R Reticuli, 7.7, 043**263**; **17,** R Carinae, 4.6, 092**962.** April 7, S Gruis, 7.8, 221**948**; 8, RT Cygni, 7.4, 194048.

These predictions of variable star maxima are by Leon Campbell, honorary recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

PHASES OF THE MOON

Full moon	March	4,	10:34
Last quarter	March	11,	2:38
New moon	March	18,	15:20
First quarter	March	26,	20:09
Full moon	April	2,	20:49

	March	Distance	Diameter
Perigee	6d 13h	225,400 miles	32′ 56″
Apogee	22d 11h	252,100 miles	29′ 27″
	April		
Perigee	3d 20h	222,800 miles	33′ 20″

MINIMA OF ALGOL

March 3, 1:14; 5, 22:04; 8, 18:53; 11, 15:42; 14, 12:31; 17, 9:21; 20, 6:10; 23, 2:59; 25, 23:49; 28, 20.38; 31, 17:27.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope,** Vol. VII, page 260, August, 1948, for further explanation.

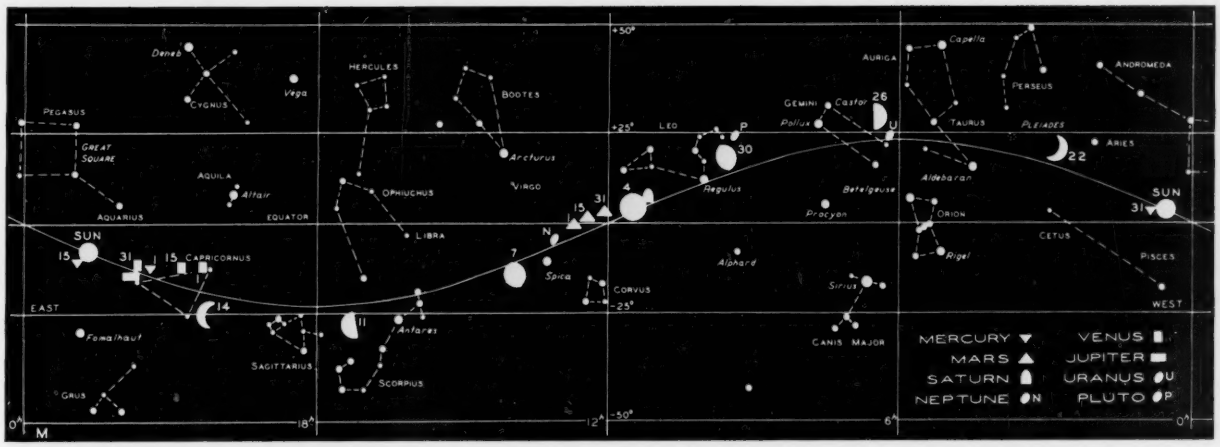
SKY-SCOPE
The new and improved 3½-inch Astronomical Telescope that amateurs everywhere are talking about.
Completely Assembled — **$25.00**
Equatorially Mounted, 60 Power
¼-wave Aluminized Mirror
Ramsden Type Ocular
100x & 35x Supp. Eyepieces, ea. **$5.00**
We invite your attention to our free brochure describing in a straightforward manner the instrument's amazing performance.
THE SKYSCOPE CO., INC.
475-a Fifth Avenue, New York 17, N. Y.

RAMSDEN EYEPIECES
$4.20 each
Professional Make — Excellent Optics
Brass mounts, 1¼" dia., easily cleaned, 1", ½", ¼" equivalent focal lengths
Low prices on 5" and 6" achromat blanks. Send for information.
DE PALMA OPTICAL CO.
13031 Oxnard Blvd., Van Nuys, Calif.

WE REPAIR
★ *Microscopes* ★ *Telescopes*
★ *Field Glasses* ★ *Binoculars*
WE BUY, SELL, EXCHANGE OPTICAL AND SCIENTIFIC INSTRUMENTS
WAELDIN 10 Maiden Lane New York City BEekman 3-5393

AN ALBUM OF CELESTIAL PHOTOGRAPHS
By A. L. Bedell
A selection of astronomical pictures by the world's large telescopes.
65 pictures with separate captions, bound in a heavy paper cover, originally priced at $1.50, now closing out at $1.25 postpaid.
SKY PUBLISHING CORPORATION
Cambridge 38, Massachusetts

EYEPIECE AND OBJECTIVE BARGAINS
Send for Free List
F. W. BALLANTYNE
P. O. Box 382
Point Pleasant New York



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

The sun will be partially eclipsed on March 18th, as viewed from the South Atlantic and Antarctica. Over a small region of the earth's surface there will be an annular phase with the sun close to the horizon, but the eclipse will have little scientific importance.

Mercury, in the morning sky, is poorly situated for observing and passes superior conjunction with the sun on March 28th.

Venus attains greatest brilliancy in the morning sky on March 6th. Rising over two hours before the sun, the planet will shine with a brightness of −4.3. Telescopically, in mid-March, its disk will appear 35″ in diameter and 33 per cent illuminated.

The earth reaches heliocentric longitude 180° on March 21st, at 4:36 UT. For the United States, therefore, late on March 20th spring will commence. South of the equator the March equinox marks the beginning of autumn.

The moon will be eclipsed on April 2nd, but this event will be seen only in the Eastern Hemisphere and parts of South America. The magnitude of total eclipse will be 1.039, mid-eclipse occurring at 20:44.1 UT. Moonrise that evening along the eastern seaboard of the United States will occur after the moon has left the umbra of the earth's shadow.

Mars, retrograding rapidly in Virgo, comes to opposition on March 23rd at 6h UT. However, its closest approach to the earth will be four days later, the ruddy planet being 60,400,000 miles distant. Mars is bright, its magnitude at opposition being −1.1, but its disk is only 14″.4 in diameter. Favorable oppositions do not occur until 1954 and 1956. Mars passes less than 1° north of Gamma Virginis on the morning of March 1st.

Jupiter rises less than an hour before the sun at the beginning of the month, in Capricornus and of magnitude −1.6.

Saturn, in Leo, reaches opposition on March 7th, 779,000,000 miles from the earth. Its magnitude is +0.7, fainter than the usual opposition magnitude, due to the small inclination of the rings. They are tilted 3°.2 on this occasion, their major diameter 44″.8, minor 2″.6. The polar diameter of the planet is 18″. Saturn has two close conjunctions with the moon: March 4, 15:41 with the planet 21′ north; March 31, 22:55, with the planet 8′ north. The **Handbook** of the British Astronomical Association lists occultations of Saturn for Australia and New Zealand on March 4th, and for South Africa on March 31st.

Uranus, in Gemini, is of the 6th magnitude and visible in the evening hours only. See the chart of its path in the February issue.

Neptune rises shortly after sunset, located in central Virgo. A chart of its path is in the February issue. E. O.

OCCULTATION PREDICTIONS

March 27-28 **Upsilon Geminorum** 4.2, 7:32.8 +27-00.5, 9, Im: **E** 0:07.4 ... ... 33; **F** 23:26.5 −2.0 +1.5 79. Em: **E** 0:36.8 ... ... 353; **F** 0:50.9 −2.4 −1.3 301.

March 31-April 1 **Sigma Leonis** 4.1, 11:18.6 +6-18.2, 13, Im: **F** 4:09.0 −3.5 +1.6 76; **H** 3:27.3 −1.4 +0.9 97. Em: **F** 4:51.5 +0.5 −4.0 9; **H** 4:28.0 −0.8 −1.7 336.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

SKY-GAZERS EXCHANGE

Classified advertising costs 8 cents a word, including address; minimum charge $2.00 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the first of the month preceding month of issue; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

ELECTRIC DRIVES with clutch and mounting bracket made to suit your telescope. $60.00 F.O.B. Inquiries invited. Fellows Engineering Works, Middle Haddam, Conn.

FOR SALE: Mounted 4″, 5″, and 6″ refractor objectives of first quality. $60.00, $180.00, $300.00. Correspondence invited. Earl C. Witherspoon, Sumter, S. C.

8″ CASSEGRAINIAN telescope for sale — reasonable. Manufacturer Tinsley Laboratories. 21 months old. Equatorial mounting. Four eyepieces, maximum 512x. Solar diagonal with filters. Correspondence invited. Skyview Observatory, P. O. Box 1231, Salinas, Calif.

ASTRONOMICAL telescope mirrors made to your specifications unaluminized, 4¼″, 6″, 8″ diameters. $20.00, $30.00, $70.00, respectively. Guaranteed to be of the highest optical quality. P. Klatt, 3107 Guilford St., Philadelphia 15, Pa.

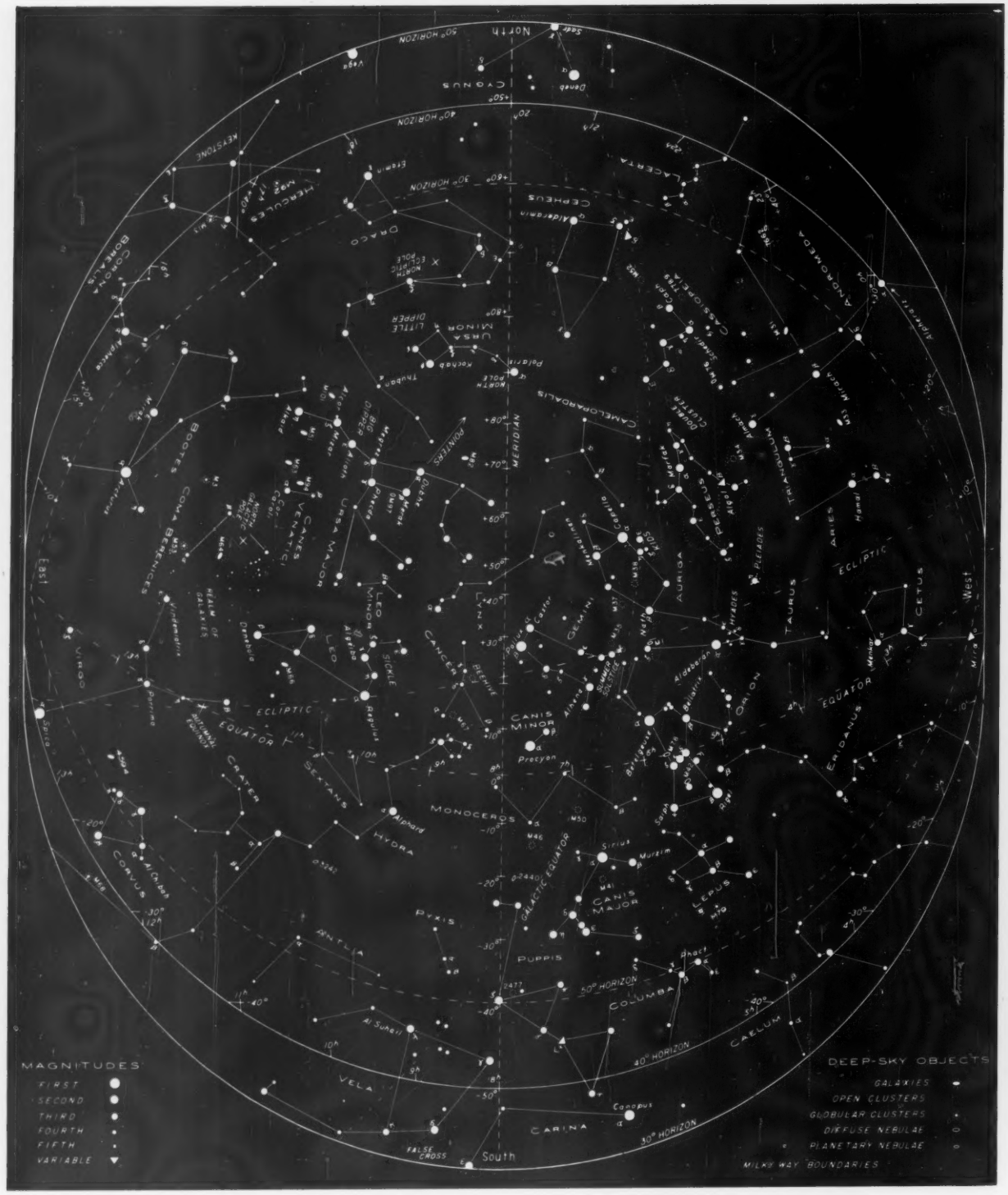
SEE BEAUTIFUL spectrum pattern around bright stars with our processed diffraction screen. Placed in front of any amateur's telescope objective, refractor or reflector, it diminishes planetary glare making detail better; also aids seeing faint companion stars. It will please you and amaze friends looking through your scope. In reflectors screen is placed in mouth of tube. Be sure to give O.D. of your cell block or tube. Simple to attach or take off. Screens up to 4″ diameter, $1.00; up to 12″, $2.00. Order now this amazing little gadget that will startle you in operation. Money refunded if not satisfied. Hal W. Metzger, Alfred Station, N. Y.

FOR SALE: Black laminated fiber tubing, 2.94″ I.D. x 3′ and aluminum cell for 3″ lens or mirror (specify). $3.00. Separate $1.75 each. David Sturgill, Berwyn, Md.

TELESCOPES and all accessories bought, sold, or exchanged. Valley View Observatory, 106 Van Buren St., Pittsburgh 14, Pa.

SAVE 50% on new binoculars! Free catalogue. Free book, "How to Select Binoculars." Write today. Bushnell Importers, 41-Y East Green, Pasadena 1, Calif.

FOR SALE: One astronomical telescope mirror 5″, with 67″ focal length, eyepiece holding and focusing device, diagonal mirror made by Harry Ross. #3 modified Ramsden eyepiece by B&L. One elbow telescope, eight power. Price $25.00. Write Clyde Hopson, 2115 Norfolk, Houston 6, Tex.



The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of March, respectively.

STARS FOR MARCH

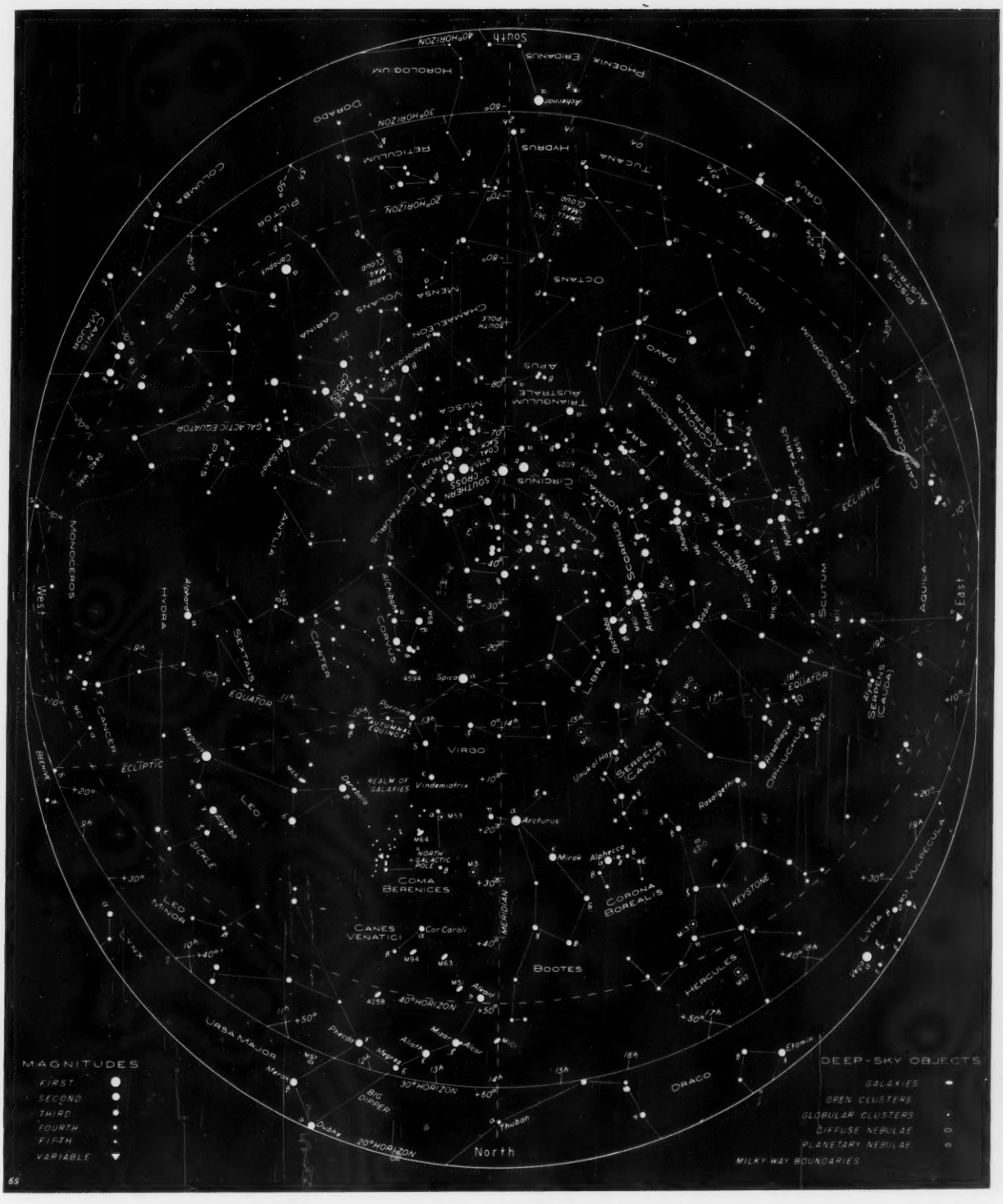
FURTHER DISCUSSION of various aspects of star charts in general and of **Sky and Telescope** maps continues here from the January and February issues.

Reference circles. The circles which mark the various horizons to make these maps useful in different locations over the earth have already been discussed in January under the section on **Latitude of observer.** Four other great circles appear on the charts, the celestial equator, the ecliptic, the meridian, and the galactic equator. The celestial equator, 90° from the north and south celestial poles, one of which appears on each chart here, is a projection of the earth's equator to the celestial sphere. By means of the celestial equator and a grid of co-ordinates in the sky similar to our latitude and longitude on earth, positions of objects on the celestial sphere can be accurately indicated.

The ecliptic is the projection of the sun's path onto the celestial sphere. Along it, could we see the stars in the daytime, could be plotted the position of the sun on succeeding days of the year. As the earth makes its annual trip around the

---

Chart Correction: Bellatrix, in Orion, should be Gamma instead of Beta.



The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of June, respectively.

SOUTHERN STARS

sun, we on the earth looking out at the sky seem to see the sun moving gradually among the constellations. More important to star chart users, it is this same apparent motion of the sun along the ecliptic annually which brings into the night sky different constellations with the different seasons, as the sun moves eastward and "blots out" the groups ahead of it.

Because the sun's family of planets moves around it in nearly the same plane, all the planets are observed near the ecliptic.

The celestial meridian, like the horizon, is a "local phenomenon" — each observer's overhead point, his zenith, is different, and through each zenith can be drawn an imaginary meridian, running also through the north and south poles of the sky and marking north and south on the horizon. The celestial meridian remains fixed for an observer staying in one place, while the celestial sphere, with the equator and ecliptic seemingly drawn on it and the stars fastened against it, slips around from east to west through the night.

The galactic equator belongs to the galaxy, as the name implies. It stretches around the sky 90° between the poles of the Milky Way plane. Note the positions of these galactic poles on the charts.